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LOKI WIND CORRECTION COMPUTER

by

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and

WIND STUDIES FOR LOKI

by

Bernard Helfand

August 1, 1953

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and Report for Fourth Quarter
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Annual Summary

The work performed during the first year of the LOKI Wind Correction Computer development program has fallen into four phases, described in detail in the North American Instruments, Inc. Quarterly Report series.

In the first phase, the effect of an arbitrary wind distribution on the LOKI trajectory during boost was determined by an impulse response method, and a function was derived relating burnout deviation of flight path with the distributed wind along the boost trajectory. Complete details of the derivation are included in the First Quarterly Report, Ref. 5. To verify the theoretical influence function, arrangements have been made for an experimental comparison at White Sands Proving Ground. The Signal Corps is erecting ten poles instrumented with anemometers at the launching site of the Small Missiles Range, for this purpose. This system is expected to be in operation within the next few months.

In the second phase, the wind influence function was then applied to arbitrary and observed wind distributions with a view to establishing the basis for a practical field wind measuring system to transmit information to a computer which could perform an aiming correction. The studies indicated the feasibility of a correction method

based on a linear relationship between burnout deviation and wind, suitably measured, at a limited number of fixed stations. This work is described in the Second Quarterly Report. The conclusions are supported by further studies included in this report.

To supplement immediately the wind data obtained from the literature, which extend up to 250 feet altitude (50% of the burnout deviation effect), with measurements extending to 1,000 feet of altitude (94% of the burnout deviation effect), a balloon-borne hot wire anemometer system was constructed and put into field operation, data being gathered in the Mojave Desert at El Mirage Airport, and at White Sands Proving Ground at the Small Missiles Range. The equipment is described in the Third Quarterly Report. A more complete program involving space and time variations of wind within a volume significant in the general rocket aiming problem has been set up under the sponsorship of the Signal Corps. The system involves the erection of a number of high towers and the operation of a complex data recording system. It is expected that data will become available from this project within the next year.

At the outset of the computer development program the possible need was recognized for an anemometer capable of fast response, to provide orthogonal wind components in terms of electrical outputs. No such instrument was available and a design was undertaken based on the drag force exerted by the wind stream on a transverse cylinder.

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The development of this 2-component anemometer constituted the third phase and extended through most of the year and resulted in a prototype unit suitable for field operation. Details on the design and wind tunnel testing of the anemometer are contained in the Third Quarterly Report.

The final phase of the past year's work, described in this report, has been the design of a complete wind correction computer system based on the influence function and the results of the wind studies.

Acknowledgment

We wish to acknowledge helpful discussions, held during the preparation of this report, with members of the Bell Telephone Laboratories on the subjects of Computer Geometry and Components.

PART I

WIND CORRECTION COMPUTER

Introduction

The purpose of the computer which is the subject of this report is to correct the aim of a rocket launcher (in both azimuth and elevation) for the wind forces experienced by the rocket during its burning period. As a result of a statictical study of winds within a few hundred feet of the ground, it is believed that the effect of these so-called surface winds upon the rocket trajectory can be expressed by a linear relation involving the two horizontal wind components at or near the rocket launcher. The details of the wind structure study are presented in this report and in an earlier one, Ref. 1, and the anemometer used in both the wind study and in the wind correction computer has been described earlier, Ref. 2.

The angular deviation at the end of burning due to wind normal to the trajectory, amounts to approximately one mil (thousandth radian) per mile-per-hour; it is not expected that rocket launching will be attempted in winds above 40 miles per hour. Current experimental rocket dispersions amount to 8 mils (linear standard deviation), and a wind correction standard deviation of about 2 mils thus appears acceptable.

Operating Principle of Computer

The wind correction computer corrects the point of aim of the rocket launcher for deviations from its intended trajectory due to wind. The corrections are made in both azimuth and elevation; both corrections are inserted as rotations of the shafts of differential selsyns interposed in the transmission lines between the main fire control director (M33) and the launcher. The wind correction computer is physically separate from the main fire control director and may be remote from it.

The wind data received from the anemometer is in the form of two amplitude-modulated 3000 cps signals; the amplitudes are proportional to $V^2\cos\theta$ and $V^2\sin\theta$, the northerly and westerly components of the square of the wind velocity; the wind is assumed to lie in the horizontal plane. Here V is the wind velocity and θ is the wind vector heading angle measur[illegible] counter-clockwise relative to true north. Because the anemometers do not deliver actual velocity components, the computer must convert $V^2\cos\theta$ and $V^2\sin\theta$ into $V\cos\theta$ and $V\sin\theta$, respectively. Secondly, if the anemometer is fixed in orientation, (i.e., not slaved in azimuth to the launcher), it is necessary to carry out the vector rotations which resolve the northerly and westerly wind components into down-range and cross-range winds; this is achieved in the computer by sine and cosine potentiometers and operational adders. If A is the azimuth

angle of the launcher, the desired quantities are:

$$V\cos(\Theta - A) = (V\cos\Theta)\cos A + (V\sin\Theta)\sin A \tag{1}$$

$$V\sin(\Theta - A) = -(V\cos\Theta)\sin A + (V\sin\Theta)\cos A \tag{2}$$

We may replace $(\Theta - A)$ by $\emptyset$, the wind heading relative to the launcher azimuth.

Since only those wind components normal to the trajectory are effective in producing deflections of the trajectory, the angular rotation due to wind may be resolved into two angular rotations normal to the trajectory. The horizontal and vertical angular deviations W_h and W_v, respectively, may be obtained by the geometric relations, illustrated in Fig. 1. Because of the smallness of the angular deviation, the deviation resolves in the same manner as the wind force which causes it. The incremental angles are:

$$W_h = KV\sin\emptyset \tag{3}$$

$$W_v = KV\cos\emptyset \sin E \tag{4}$$

where E is the corrected angle of launcher elevation and K is the influence coefficient relating wind (in mph) to angular deviation (in mils).

It should be remembered that the deviations are angular and the incremental vectors, W_n, W_h, and W_v are chords of a unit sphere. Fig. 2 illustrates the spherical trigonometric relations utilized in deriving the wind corrections in azimuth and elevation.

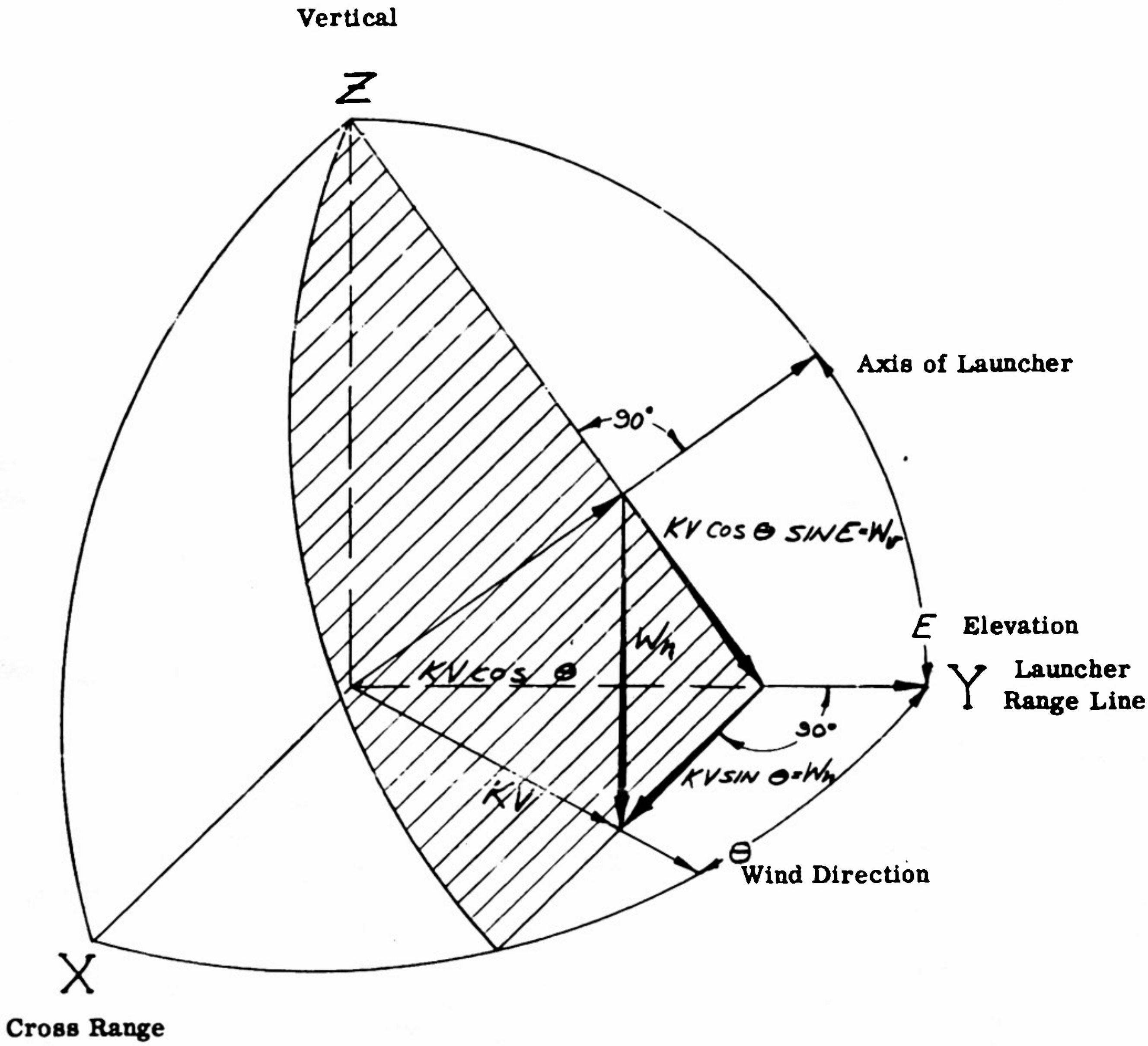

FIG. 1 RESOLUTION OF WIND VECTOR OR ANGULAR DEVIATION

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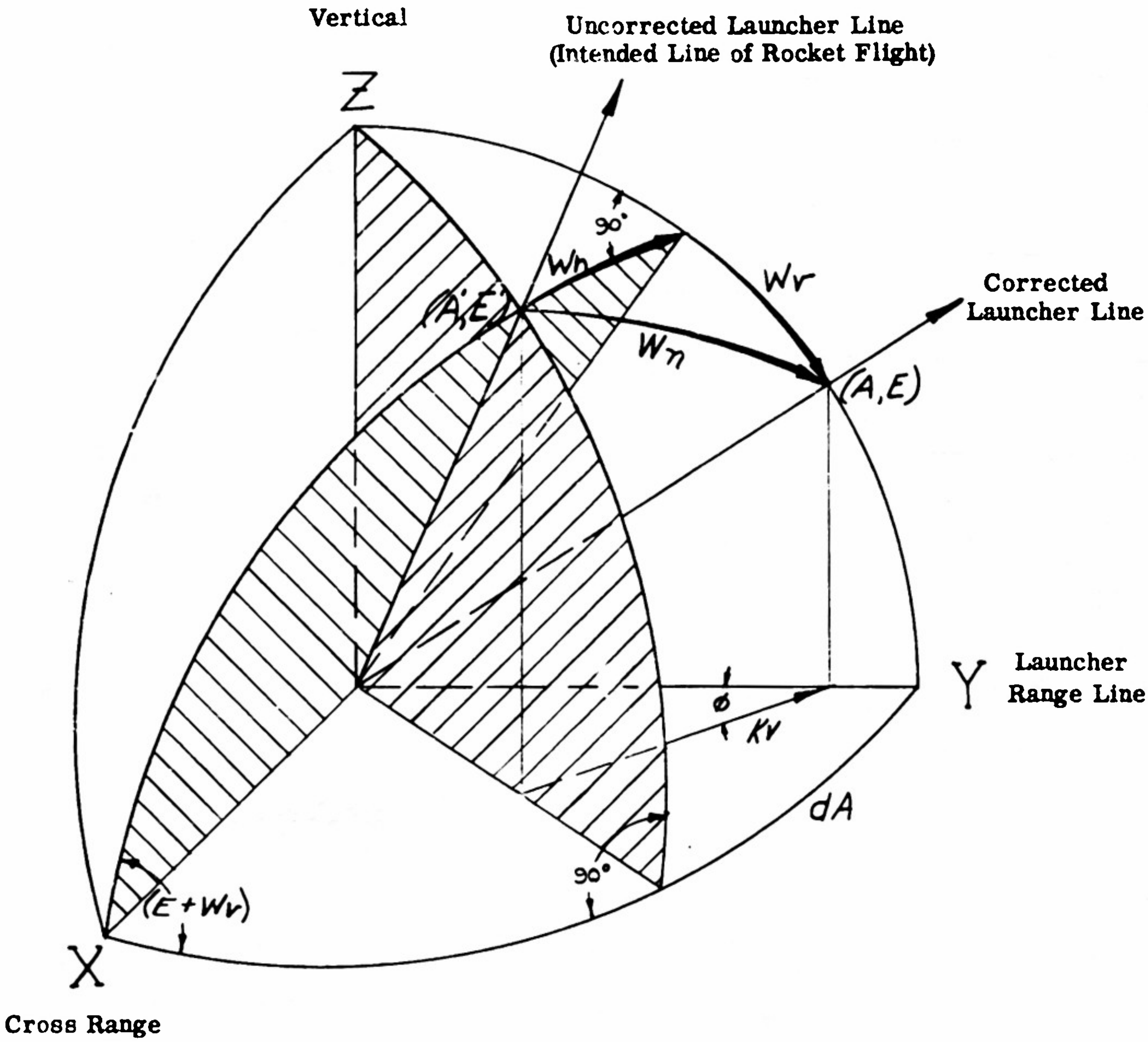

FIG. 2 RESOLUTION OF ANGULAR DEVIATION DUE TO WIND INTO AZIMUTH (A) AND ELEVATION (E) CORRECTIONS. PRIMED QUANTITIES ARE UNCORRECTED OR "AIM-POINT" VALUES.

By the law of sines, one may write

$$\sin dA = \sin W_h / \cos E' \tag{5}$$

The quantity $\sin W_h$ may be replaced by W_h to within one part in 4,000; sin dA cannot be replaced by dA because dA may be as great as 560 mils; thus the equation for dA may be written:

$$\sin dA = W_h \sec E' \tag{6}$$

The correction in elevation, dE, may be written by a second application of the law of sines as:

$$\sin (E + W_v) \doteq \sin E' / \cos W_h \tag{7}$$

We shall want the expression in a form not involving E, so we substitute

$$E = E' + dE \tag{8}$$

with the result:

$$dE \doteq -W_v + \frac{W_h^2}{2} \tan E' \tag{9}$$

In writing Equation (9), we have made use of the approximations:

$$\cos (dE + W_v) \doteq 1 \qquad 0.3\% \tag{10}$$

$$\sin (dE + W_v) \doteq (dE + W_v) \qquad 0.1\% \tag{11}$$

$$\cos W_h \doteq 1 - \frac{W_h^2}{2} \qquad 10^{-5}\% \tag{12}$$

Equations (3), (4), (6), and (9) provide the mathematical basis for the computation of wind corrections. Equation (4) involves the angle E while all other relations involve E'.

If we denote

$$W'_v = KV \cos \phi \sin E' \tag{13}$$

then

$$(1 + W'_v \cot E')\, dE = -W'_v + \frac{W_h 2}{2} \tan E' \tag{14}$$

Because of the small magnitude of W'_v, neglect of the term $W'_v \cot E'$ causes an error of less than 4% in dE. Hence, to within 1.6 mils, Equation (9) may be replaced by

$$dE = -W'_v + \frac{W_h 2}{2} \tan E' \tag{15}$$

the corrected elevation, E, does not appear in any of the computer relations and no servo shaft positioning device need be provided for it. If desirable, the computer can be arranged to avoid this slight error. Fig. 3 indicates a solution utilizing Equation (14).

Computer Block Diagram

Fig. 3 presents a block diagram of the wind correction computer. The five horizontal dashed lines represent mechanical shafts, positioned by servomotors on the right; several linear or functional potentiometers are placed on each shaft; indicating dials (and selsyn or potentiometer transmitters, if required) are on the left side of the diagram.

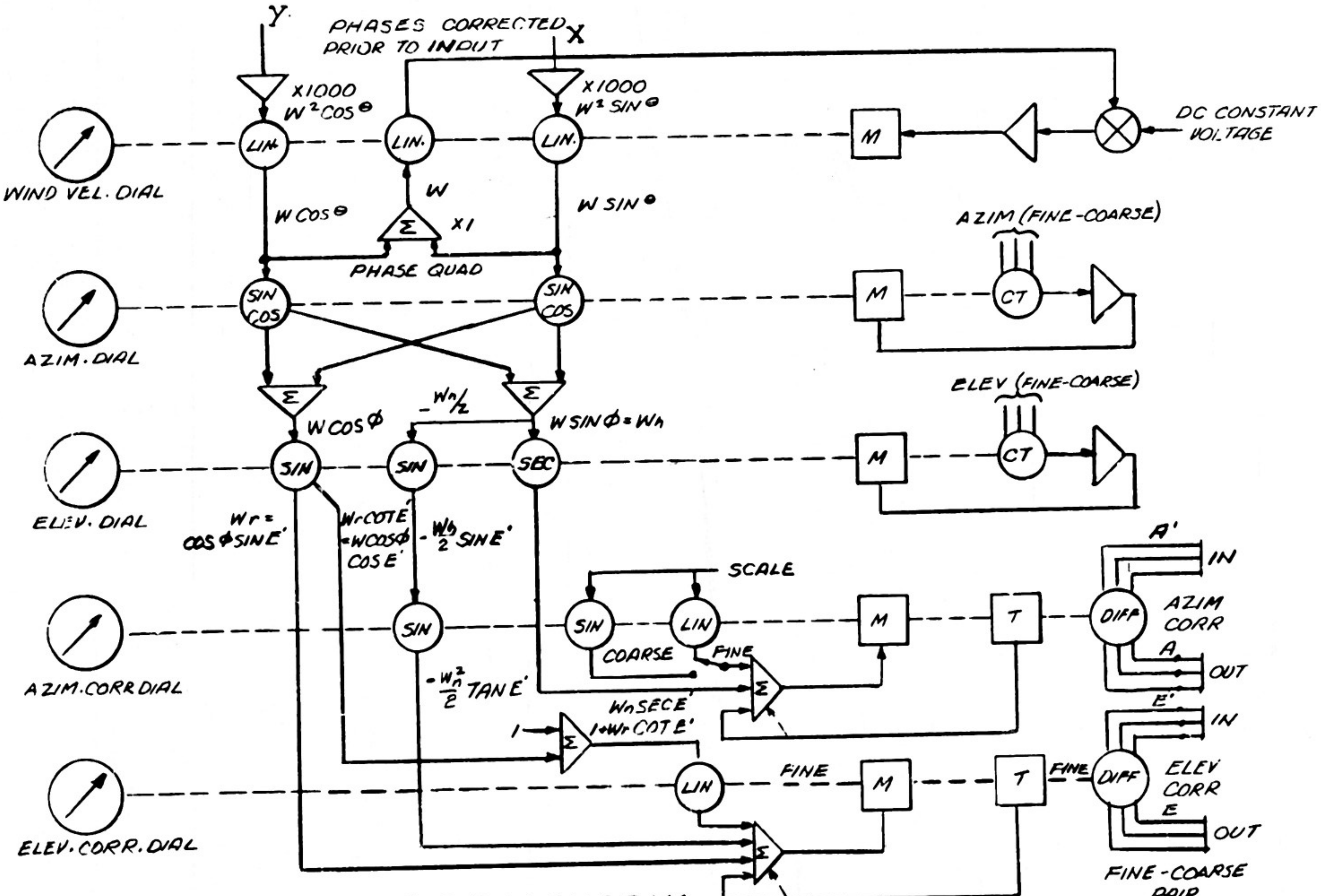

FIG. 3 COMPUTER BLOCK DIAGRAM

The manner in which the computer executes the mathematical relations may be seen fairly readily. The two anemeometer component signals $W^2 \sin \theta$ and $W^2 \cos \theta$, are amplified to suitable level and introduced at the top of Fig. 3. The three linear potentiometers and the quadrature superposition unit are used for extracting the square root of V^2 and dividing each of the input signals to yield $W \cos \theta$ and $W \sin \theta$. These signals are combined by means of the azimuth sine-cosine potentiometers and subsequent adding amplifiers to produce the components of the correction relative to the instantaneous launcher heading, $W \cos \phi$ and $W \sin \phi$.

Several functional potentiometers are employed to modulate the $V \cos \phi$ and $V \sin \phi$ signals by $\sin E'$, $\cos E'$, and $\sec E'$; the outputs from these functional potentiometers are combined in several ways by adding amplifiers and the resulting signals are balanced by output servos against the signals derived from other potentiometers mounted on the output shafts.

Square-Root Techniques

The potentiometer cascade utilized in the computer schematic of Fig. 3 is rather simple in principle, but may lead to significant dynamic error in operation due to the slowness of the servo-balancing as compared to wind fluctuations. An analysis of the dynamic error due to this cause has not yet been carried out; however, it is apparent that the error

may amount to several percent unless the input signals are damped to correspond to the servo capabilities.

Damping may be achieved by means of an orifice in the anemometer (up to about 15 seconds time constant) or by filter networks placed in d. c. sections of the computer; experimentally, the latter method is more appealing because of the possibility of switching damping values. However, it is convenient to avoid the troubles of d. c. amplification in the computer by using the 3000 cps signals throughout; this favors mechanical damping. To lessen the importance of this controversy, it is contemplated to make the experimental computer convertible insofar as possible from a. c. to d. c. signal operation; this is the reason reactive resolvers are not used. If d. c. operation is employed, a. c. signals are none the less required through the quadrature circuits, and the rectification must take place after the square root has been extracted.

To eliminate the possible source of dynamic error in square rooting, two non-servo-square-root circuits have been investigated. One type of square-rooter utilizes the non-linear properties of Thyrite, while a second type employs suppressor controlled pentodes in a feedback circuit to extract the square root; simplified breadboard computers have been built utilizing both approaches. The two methods of square rooting are treated further in the following section.

Thyrite Type Computer

The computer utilizing Thyrite as a square root extracting device combines the signals $V^2 \cos \Theta$ and $V^2 \sin \Theta$ in phase quadrature to produce a signal of amplitude V^2. The Thyrite square root extractor delivers d.c. voltages proportional to $+|V|$ and $-|V|$, which are applied to the two potentiometers. The output angular positions representing the azimuth and elevation corrections are positioned by servomechanisms effecting the following relations:

$$|V| \sin \Delta A = KV^2 \sin \phi \sec E' \qquad (16)$$

$$|V| \sin \Delta E = KV^2 \cos \phi \sin E' \qquad (17)$$

The computer requires the solution for which $|V| \neq 0$; for this reason $|V|$ is constrained to be significantly greater than zero at all times, regardless of wind. The use of a variable voltage $|V|$ across the servo potentiometers leads to a system in which the servo loop gain is variable; as is well known, this situation is usually conducive to instability under some of the desired operating conditions. This situation might be tolerated in this mode of operation because of the convenience and economy of effecting both the square root extraction and the output positioning with the same servo.

Thyrite Characteristics

The non-linear characteristics of Thyrite, a material manufactured by the General Electric Company for use in lightning arrestors, are demonstrated by the plot of Fig. 4; the graph shows the voltage across a small Thyrite element as a function of the current passing through it. The slight departure from the desired square-root dependence is almost entirely corrected by the use of a trimming resistor, in this case about 300 ohms.

A very simple Thyrite driver circuit was tried, which requires only moderate voltages; the circuit is shown in Fig. 5 and its performance is represented by Fig. 7. The 5% accuracy achieved in this trial circuit can undoubtedly be improved to correspond to the 2-3% result of the Thyrite alone.

Suppressor Type Computer

To overcome the necessity for d. c. servo amplification and to avoid the hazards of variable servo-loop gain, some tests have been made of square root extraction by means of successive suppressor controlled variable gain amplification stages. The Suppressor Type Computer utilizes this type of circuit for square root extraction. The computer shown in Fig. 3 is different from the Suppressor Type only in its use of two successive potentiometer stages for root extraction rather than suppressor controlled amplification

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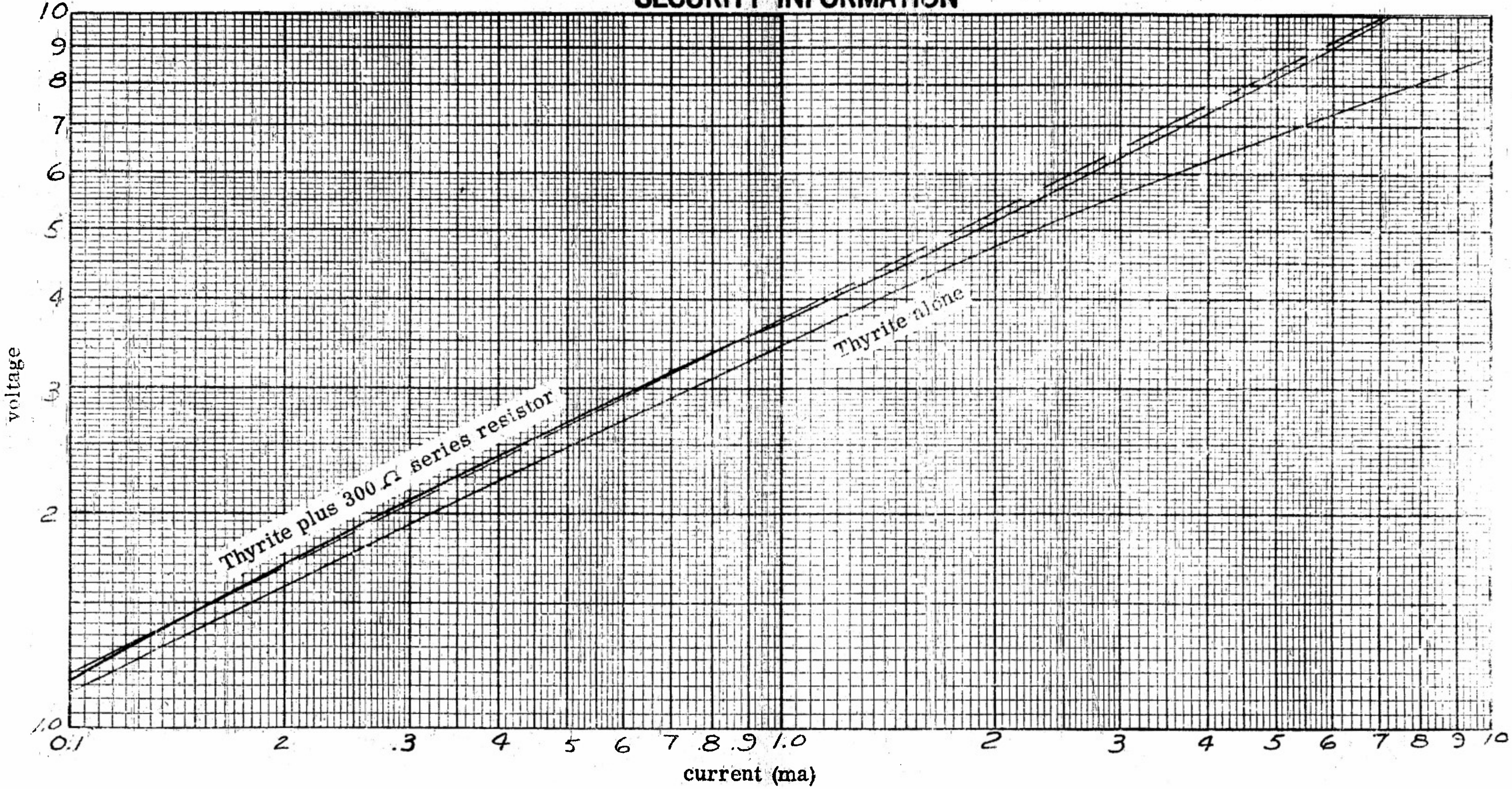

FIG. 4 THYRITE CHARACTERISTICS

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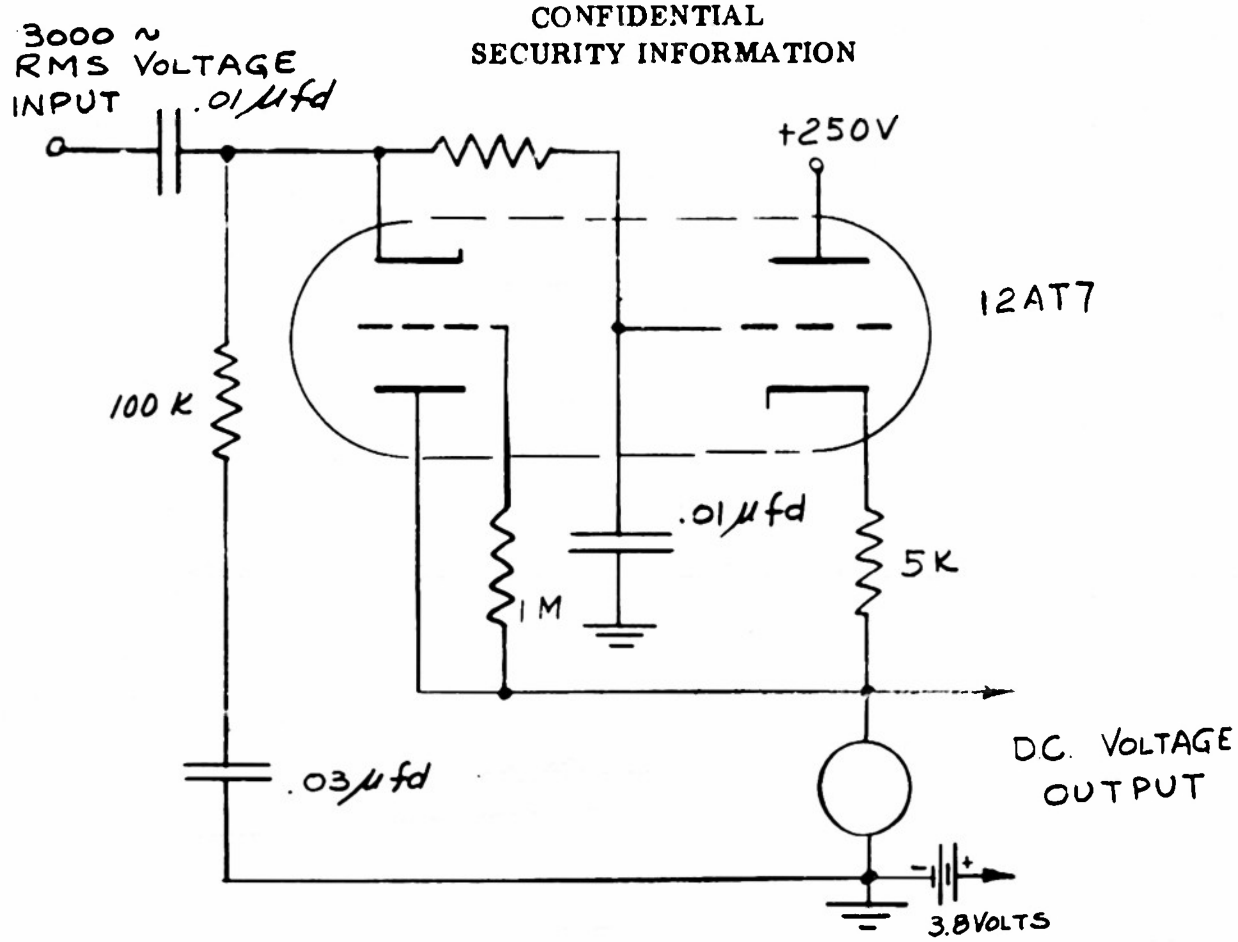
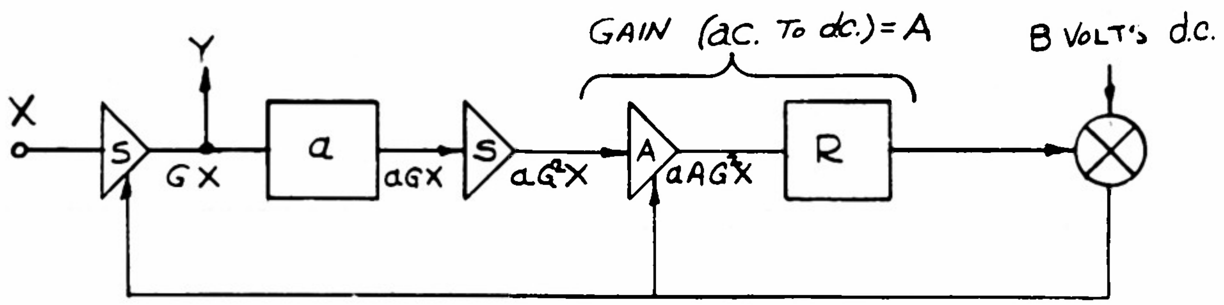


FIG. 5 THYRITE DRIVER CIRCUIT



$$\theta = B - aAX(K + \delta\theta)^2$$

G = GAIN OF THE SUPPRESSORS

$$G = (K + \delta\theta)$$

$$\theta = B - aAX(K + \delta\theta)^2$$

$$\therefore \quad K + \delta\theta = K + \delta B - aA\delta X(K + \delta\theta)^2$$

OR $$aA\delta XG^2 + G - (K + \delta B) = 0$$

$$\therefore \quad G = \frac{-1 + \sqrt{1 + 4aA\delta(K + \delta B)X}}{2aA\delta X}$$

FIG. 6 PRINCIPLE OF SQUARE ROOT EXTRACTION WITH SUPPRESSOR AMPLIFIERS

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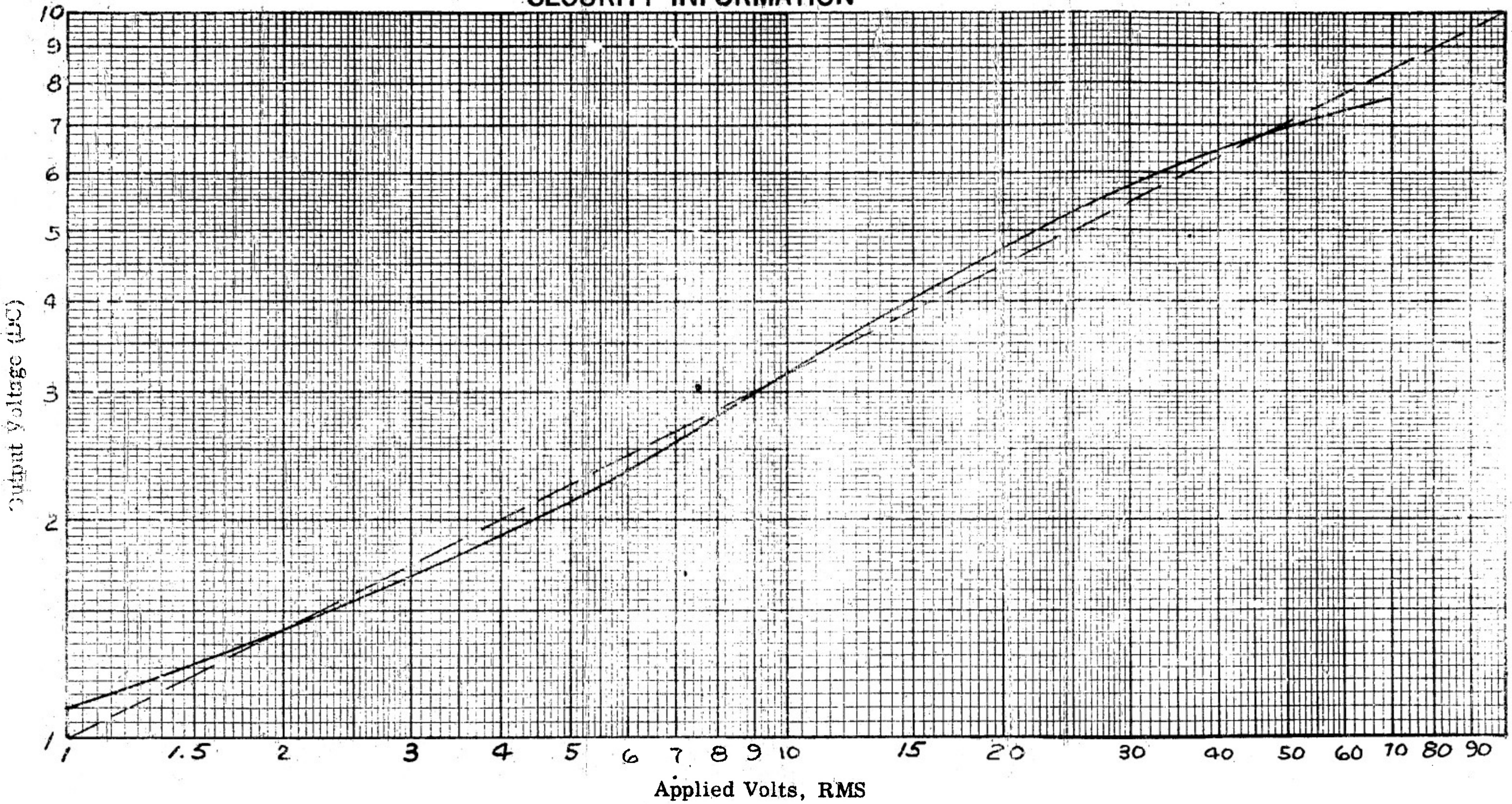


FIG. 7 THYRITE DRIVER PERFORMANCE

stages. This type of computer, whether it uses suppressor amplifiers or potentiometers for root extraction, has the advantage that no d. c. amplification is required; only simple phase sensitive rectification is required at the output stages of the servo amplifiers.

Suppressor Amplifier Root Extraction

The principle of square root extraction with a feedback circuit incorporating suppressor amplifiers is outlined in Fig. 6. The amplifiers labelled "S" are stages employing, for example, 6AS6 pentodes in which the gain can be controlled readily by the suppressor grid bias. Assuming linear characteristics in the range of operation, the gain of each stage is

$$G = \frac{-1 + \sqrt{1 + 4(K + \delta B)\,\delta\, aAx}}{2aA\delta x} \qquad (18)$$

where K is the gain of the suppressor amplifier at zero bias, δ is the change of gain per volt of bias, aA is the constant portion of the loop gain (subsequent to the suppressor amplifiers and including the rectification), and X is the input signal (RMS volts). A has the units d.c. volts per RMS volt. B is the d.c. voltage that is compared with the output of the rectifier. The output of the first suppressor stage is, therefore:

$$Y = GX \approx \sqrt{\frac{(K + \delta B)x}{aA}}\left(1 + \frac{1}{8aA\,\delta\,(K + \delta B)x}\right) - \frac{1}{2aA\,\delta} \qquad (19)$$

Typical values of the parameters are:

$K = 65$

$\delta = 6.2$ per volt

$aA = 67$

$B = 50$ volts d. c.

The calculated behavior of this system shows an error equivalent to less than 0.5 mil; experimental results are not yet available.

The suppressor amplifier square root scheme assumes that the gains of the several suppressor amplifiers vary in unison; to the extent that this is required it constitutes a strong reason against the use of the scheme in an operation computer. However, it can be shown that compensation for differences in tube characteristics can be achieved in large measure by interchanging tubes so that, for example

$$G_2 = G_1 \left[1 + \alpha(x)\right], \alpha(x) \geq 0 \tag{20}$$

and adjusting the loop gain so that, approximately

$$G_1 G_2 X = C \left[1 + \alpha(x)\right] \tag{21}$$

WIND STUDIES FOR LOKI

Introduction

In an earlier report of this project, Ref. 1, a series of vertical wind profiles was studied to determine the feasibility of a wind correction computer for LOKI, based on a linear relationship between burnout deviation and wind at a selected level. Only a limited number of wind profiles was involved in the comparison. However, significant correlations were found between computed burnout deviation and corresponding single level wind measurements. The effects of altitude and smoothing were examined, comparisons being made with wind level and time averaged velocity as parameters.

The wind data used was that of Sherlock and Stout for winter storms in Michigan, Refs. 3 and 4, and was obtained with a 250-foot tower instrumented with fast response pressure plate anemometers at 25-foot intervals. It was learned from the authors that the published information was only a small part of a large total which had been reduced from the original oscillograph records to punched IBM cards. Several thousand of these cards were available; duplicates were obtained and these were processed by the Los Angeles IBM Service Bureau to extend the initial investigation. The results of the IBM computations which are presented in this report, confirm the initial findings and permit a selection of optimum altitude and time average through the use of a wider range

of these parameters. Also comparisons were made using combinations of wind values at two altitudes. These appear to offer little improvement over appropriately smoothed single altitude winds at levels above 50 feet.

Discussion

The function relating LOKI deviation at burnout with the distributed wind along the trajectory was derived in Ref. 5 and is shown in Fig. 8 as a plot between wind influence coefficient (deviation of flight path at burnout from direction at launching per unit cross-wind per unit distance increment along trajectory) and distance of rocket from launcher. The cumulative effect of a constant crosswind during boost is shown in Fig. 9. The total deviation for unit crosswind is .8 mil, 50% being accumulated in the first 200 feet of trajectory and 95% in the first 1,000 feet.

The results of the preliminary investigation are tabulated in Fig. 10 from Ref. 1. The burnout deviations for 150 cases were calculated by integrating the wind observations weighted with the influence function and apply to a theoretical vertical shot. Since the wind observations extend to 250 feet, the deviation is about 50% of the total that would be obtained if the integration were carried to burnout.

The work discussed in this report extends the number of cases from 150 to 4,000 using the same altitudes, 25, 50, 100, and 150 feet with the addition of the mean of the 25 and

FIGURE 8
LOKI CROSSWIND INFLUENCE FUNCTION

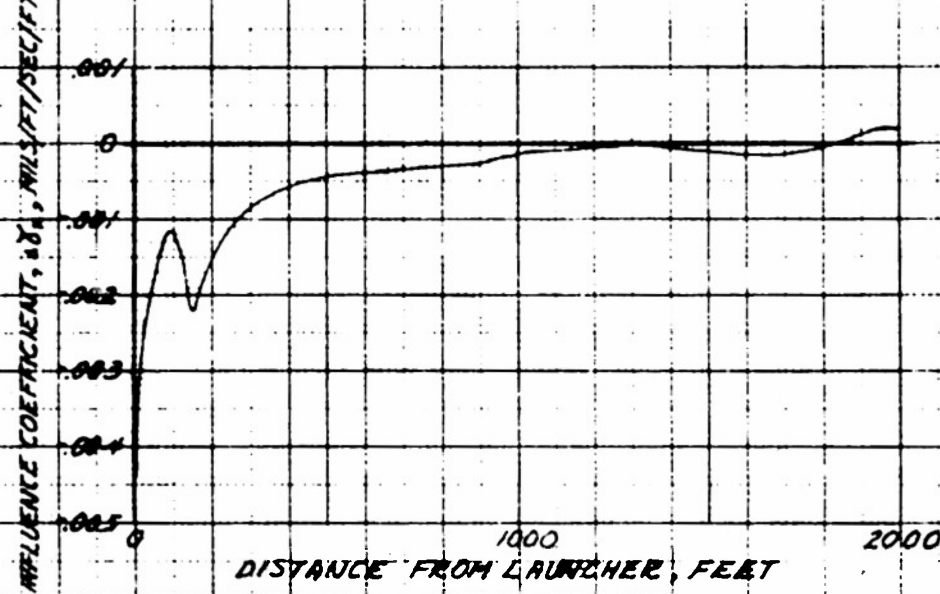
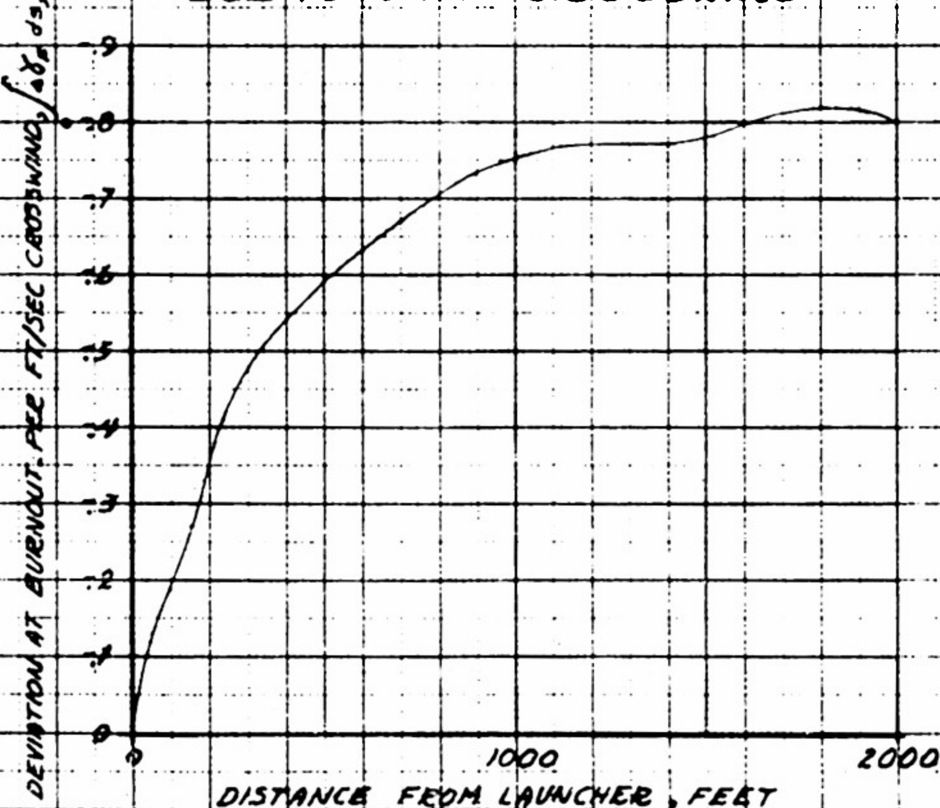


FIGURE 9
DEVIATION AT BURNOUT
DUE TO UNIT CROSSWIND



Wind Measurement Level	Wind Deviation at Burnout			4-Second Average Wind Deviation at Burnout		
	Regression Line Slope mils/mph	Correlation Coefficient	Deviation Spread for 90% Obs. mils	Regression Line Slope mils/mph	Correlation Coefficient	Deviation Spread for 90% Obs. mils
25	.544	.802	± 4.9	.582	.823	± 4.4
50	.399	.805	± 4.7	.419	.836	± 3.9
100	.488	.901	± 3.3	.491	.896	± 3.2
150	.441	.939	± 2.6	.446	.945	± 2.3

FIG. 10 SUMMARY OF RESULTS OF PRELIMINARY WIND STUDIES FOR LOKI
(Ref. 1)

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100-foot winds, and the mean of the 50 and 150-foot winds. Also the 1 and 4-second wind averages in the initial survey are augmented by the 2 and 8-second averages.

The basic wind data as received from the University of Michigan, was in the form of punched IBM cards and apply to the storms of Apr. 28, 1931 and Jan. 19, 1933. All records were originally taken continuously on oscillograph paper, information being transferred from these records onto the cards. The card code identification is shown in Fig. 11.

The first vertical column at the left identifies the run number. Each storm sample was divided into runs of various lengths, the oscillograph being operated intermittently to record during periods of major gust activity. Many runs were found to be broken, due to missing card data, and in order to provide continuous time sequences for analysis, these runs were broken into sub-groups and labelled episodes.

The second column identifies the length of time interval over which the velocity observations were averaged. Averages from 1/4 sec. to 10 sec. were available; however, the averages used in all computations were based on the 1-second cards.

The third column shows the number of seconds after the start of a run, and columns 5 to 16 show the wind speeds in miles per hour at each of the observation stations. The ten stations on the tower were at 25-foot intervals and are identified by numbers 1 to 10 reading from the bottom.

Code Identification				Velocity in MPH											
				Station Number											
Run Number	Time = 1/4 Sec.	Seconds after start of Run	Card Number 4 Int. 1/4 Sec.	1	2	3	(4)	5	6	7	8	(9)	10	11	12
025	1	000	1	22.5	25.3	23.9	000	25.1	28.7	27.9	27.8		32.2		
025	1	000	2	22.9	24.4	23.9	000	25.4	31.1	29.4	30.1		33.5		
025	1	000	3	etc.	etc.	etc.	000	26.8	29.7	29.0	31.0		33.2		
025	1	000	4								31.9		33.8		
025	1	001	1								32.8		33.5		
025	1	001	2								36.0		33.8		
025	1	001	3								33.3		34.1		
025	1	001	4								32.2		33.8		
025	1	002	1	20.4 etc.	24.9	29.3	000	29.4	27.5	28.2	31.6		36.8		

FIG. 11 IBM CARD IDENTIFICATION CODE

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Statistical comparisons were made for each run separately to determine the correlation coefficient, the slope of the burnout deviation vs. wind speed regression line and the 90% confidence limits for the burnout deviation. In calculating the burnout deviation sequences, the wind values at each altitude were assumed to describe the wind extending from the adjacent lower altitude using weighting factors determined from the influence function. The results as tabulated by IBM are presented in the Appendix.

The formulae used in the computations follow:

Correlation coefficient, r = $$\frac{N\Sigma\delta A - \Sigma A\Sigma\delta}{\left\{\left[N\Sigma A^2 - (\Sigma A)^2\right]\left[N\Sigma\delta^2 - (\Sigma\delta)^2\right]\right\}^{1/2}}$$

90% Confidence Limits, Sy_{90} = $$\frac{1.65\left\{\left[1 - r^2\right]\left[N\Sigma\delta^2 - (\Sigma\delta)^2\right]\right\}^{1/2}}{N}$$

Regression Line Slope, b = $$\frac{N\Sigma\delta A - \Sigma\delta\Sigma A}{N\Sigma\delta^2 - (\Sigma\delta)^2}$$

$$\bar{A} = \frac{\Sigma A}{N}$$

$$\bar{\delta} = \frac{\Sigma\delta}{N}$$

(Regression Line passes through $\bar{A}$, $\bar{\delta}$)

Mean Wind $A_{jmpk} = \frac{1}{m} \sum_{j-m+1}^{j} W_{jpk}$, mph

Burnout Deviation, $\delta_{jk} = K \sum_{i=1}^{9} \Delta_{ik} W_{ijk}$, mils

where

K is the episode number
j is the time in seconds after the start of a run
m is the index for moving averages, m = 1, 2, 4, 8
W is the velocity in miles per hour
Δ jk are the wind weighting factors (see table below)
K is a conversion constant, K = 88/60
i is the height of observation given in the following table:

i	Height (feet)	Wind weighting factor Δ jk
1	25	.050
2	50	.050
3	75	.030
4	100	.035
5	125	.030
6	150	.045
7	175	.050
8	200	.040
9	250	.065

p is a specified value or combination of i's as given in the following table:

$W_{p_1} = W_{i_1}$ $\qquad$ $W_{p_4} = W_{i_6}$

$W_{p_2} = W_{i_2}$ $\qquad$ $W_{p_5} = \dfrac{W_{i_1} + W_{i_4}}{2}$

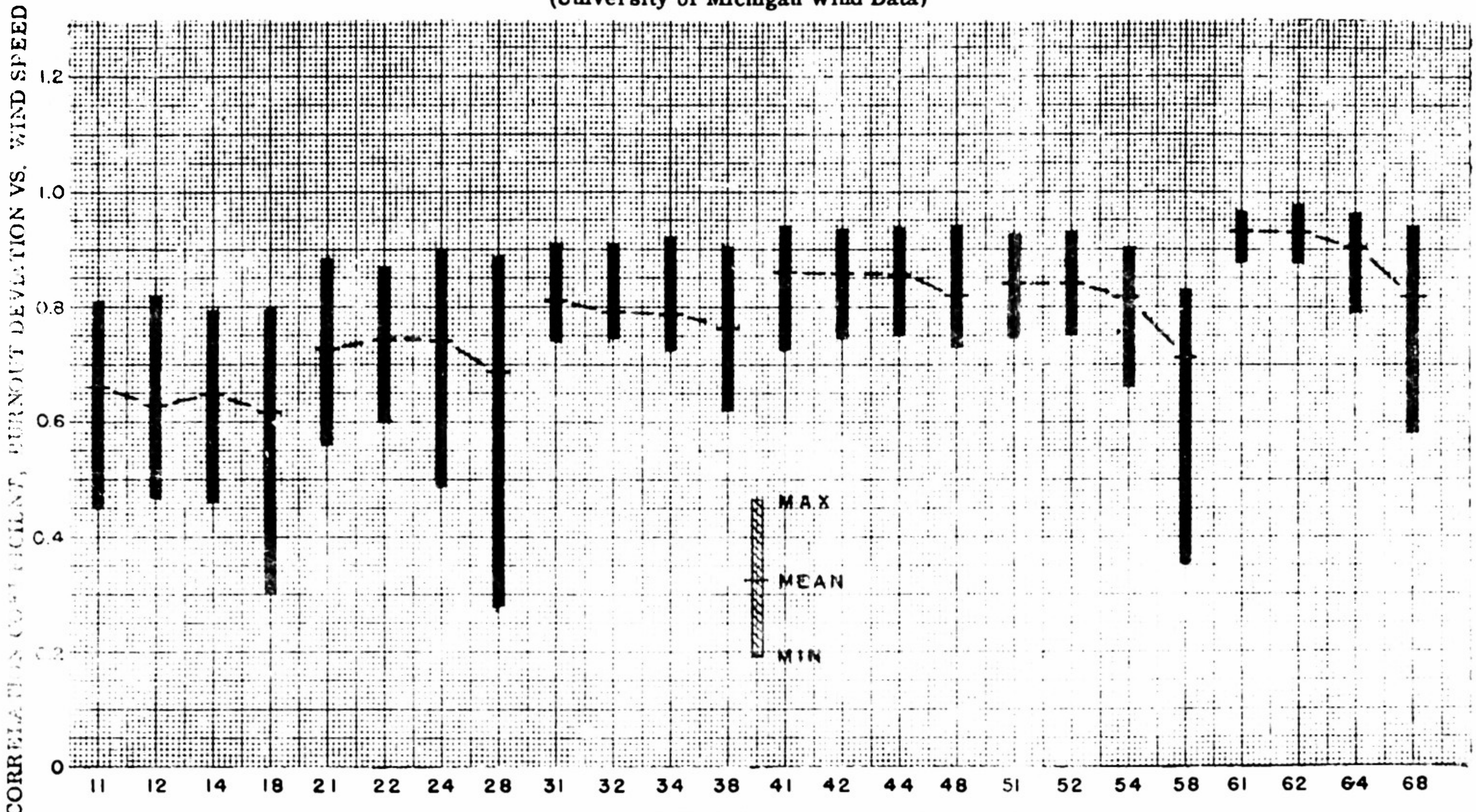
$W_{p_3} = W_{i_4}$ $\qquad$ $W_{p_6} = \dfrac{W_{i_2} + W_{i_6}}{2}$

Results are summarized in Figs. 12 through 14, which show the range and average of the three significant parameters plotted as vertical bars and each of the combinations of anemometer height and time average. Runs 17, 19, 34, and 35 have been excluded in certain cases where missing data have resulted in small sample size and resulting range extremes. The unweighted arithmetical mean is shown on each bar. Fig. 12 shows the effect of progressive increase of time average on correlation coefficient of burnout deviation vs. wind speed for progressively increasing anemometer heights from 25 to 150 feet and also for time average 25 to 100-foot winds and 50-150-foot winds. Similar progressive sequences are shown for the regression line slope in Fig. 13 and 90% confidence limits in Fig. 14.

It is evident that the 2-second average offers improved correlation and reduced spread among runs under the 1 and 4-second averages. Further, a pronounced degradation is observed with the 8-second average.

In progressing upward in altitude a marked improvement occurs in going from 50 to 100 feet with subsequent slight improvement at 150 feet. Best results are observed in the 50-150 foot mean wind sequences. However, the improvement over the 100-foot wind would hardly warrant the use of 2 anemometers in a wind correction computing system.

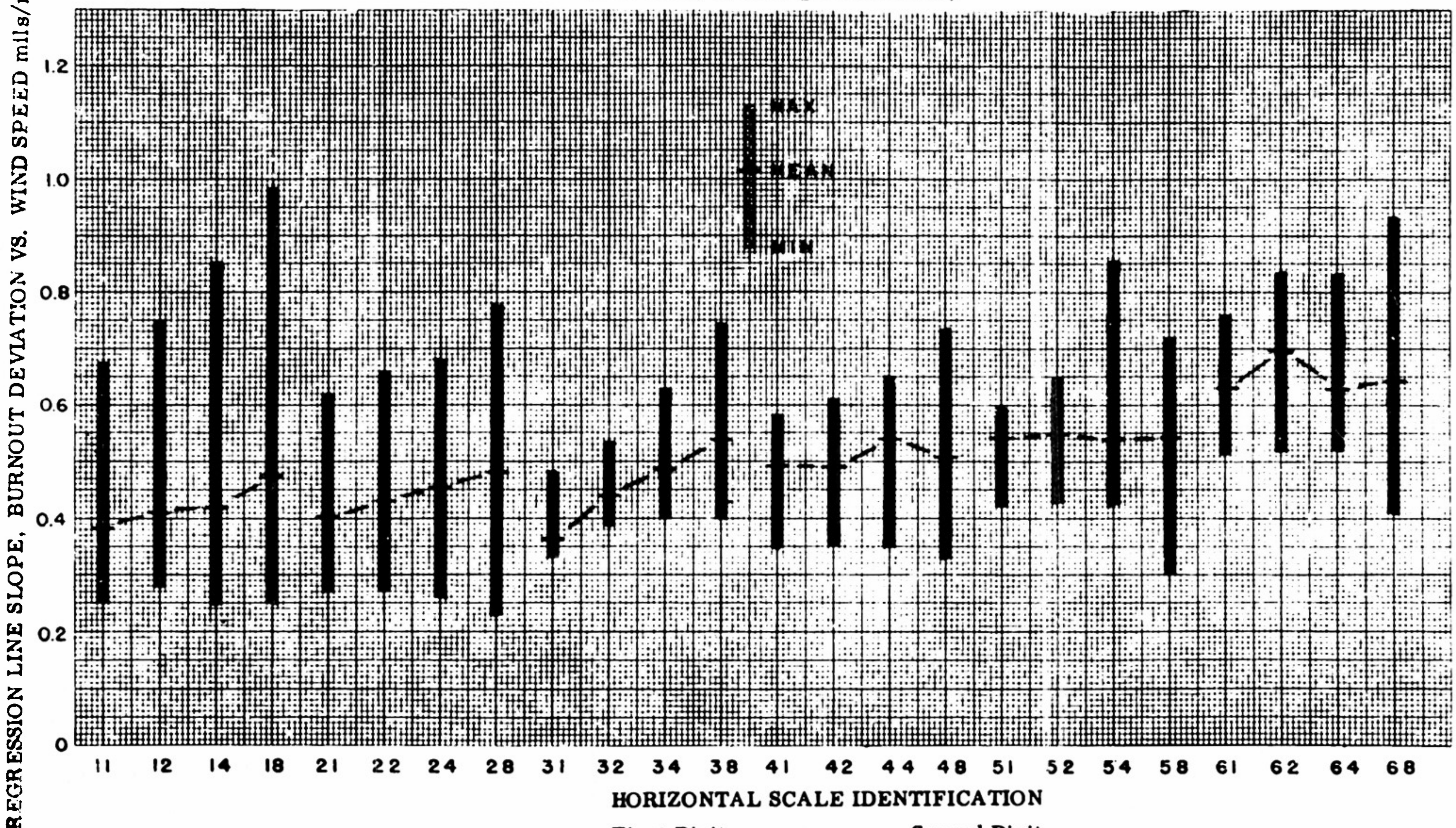
FIG. 12 EFFECT OF ALTITUDE AND AVERAGE ON CORRELATION COEFFICIENT, LOKI BURNOUT DEVIATION VS. WIND SPEED (University of Michigan Wind Data)



HORIZONTAL SCALE IDENTIFICATION

First Digit		Second Digit
Anemometer Height	- Space Av.	Time Av. (Sec)
1 25 ft.	5 25 & 100 ft.	1
2 50 ft.	6 50 & 150 ft.	2
3 100 ft.		4
4 150 ft.		8

FIG. 13 EFFECT OF ALTITUDE AND AVERAGE ON SLOPE OF REGRESSION LINE, LOKI BURNOUT DEVIATION VS. WIND SPEED
(University of Michigan Wind Data)



HORIZONTAL SCALE IDENTIFICATION

First Digit				Second Digit
Anemometer Height		- Space Av.		Time Av. (Sec)
1	25 ft.	5	25 & 100 ft.	1
2	50 ft.	6	50 & 150 ft.	2
3	100 ft.			4
4	150 ft.			8

FIG. 14 EFFECT OF ALTITUDE AND AVERAGE ON 90 PERCENT CONFIDENCE LIMITS
FOR LOKI BURNOUT DEVIATION
(Universitv of Michigan Wind Data)

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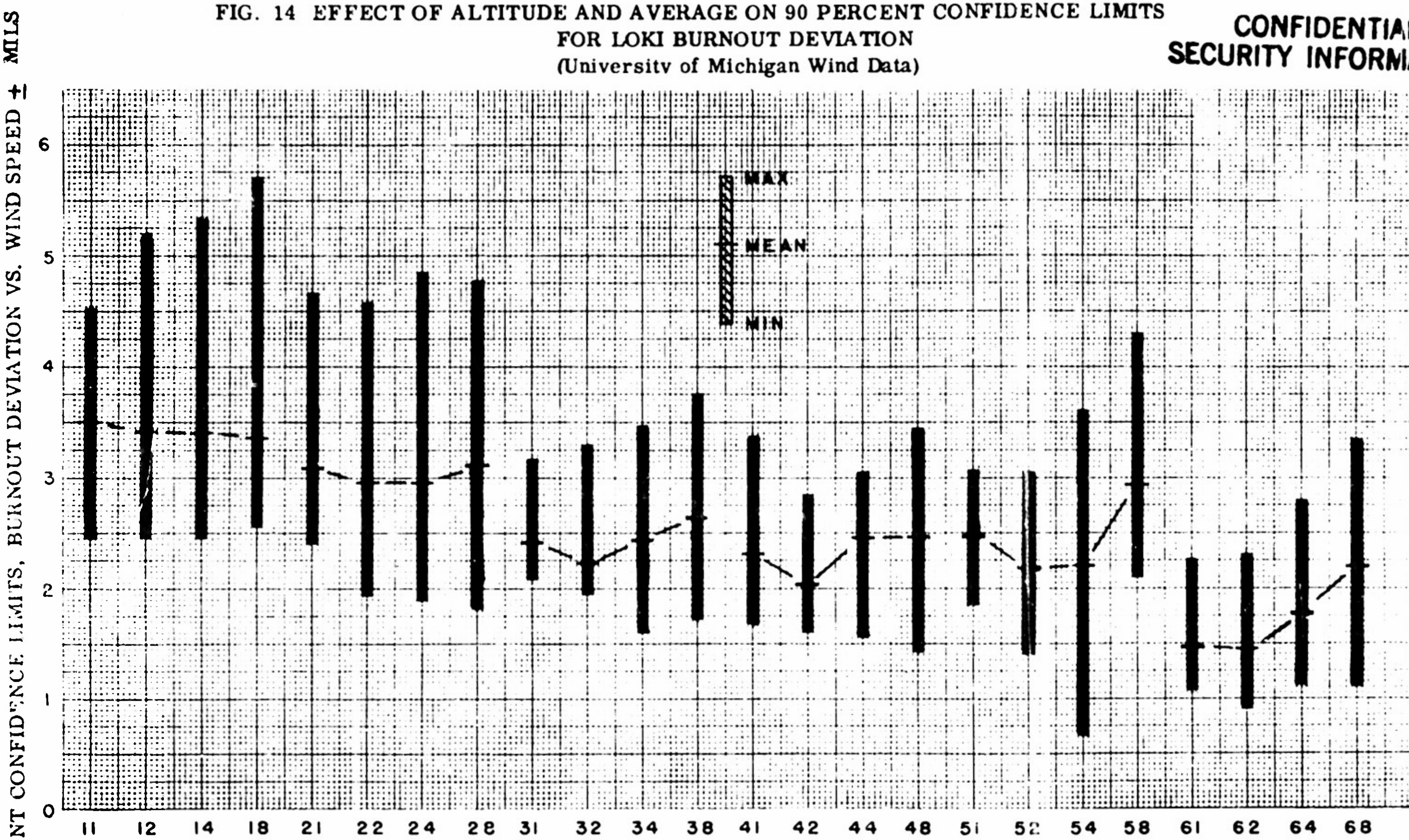

HORIZONTAL SCALE IDENTIFICATION

First Digit				Second Digit
Anemometer Height		- Space Av.		Time Av. (Sec)
1	25 ft.	5	25 & 100 ft.	1
2	50 ft.	6	50 & 150 ft.	2
3	100 ft.			4
4	150 ft.			8

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The present results are in substantial agreement with those obtained in the preliminary analysis of Ref. 1, and indicate the best choice of altitude and smoothing that would apply to vertical trajectories under the condition that would obtain at the Michigan test site in winter storm conditions.

For an anemometer height of 100 feet and 2-second average, the correction for wind effect in the first 250 feet of a vertical trajectory (about 50% of the total) could be expressed by the relation:

$$-\delta_c = 0.48W + 4$$

where δ = burnout deviation correction, mils

W' = 100 foot 2-second average wind velocity, mph,

the 90% confidence limits would be $\pm$ 2 mils.

Supplementary data obtained from hot wire surveys up to 1000 feet at White Sands Proving Ground and El Mirage Airport, using equipment described in Ref. 3, is now being analyzed and should permit the establishment of a tentative wind correction correction equation for the entire boost phase.

The effects of horizontal separation between the anemometer and launcher, elevation angle of launching, terrain and weather conditions, must also be considered in the design of a tactical system. These will be investigated in the Signal Corps sponsored project which is now being conducted by North American Instruments, Inc.

APPENDIX

STATISTICAL RESULTS OF LOKI BURNOUT DEVIATION VS. WIND VELOCITY COMPARISON

The tables which follow present the results of the statistical computations described above, p. 15, and are direct photographs of the original IBM records. The accuracy is no better than 3 figures, the additional figures were allowed to appear as a matter of convenience in machine operation.

The identification code for the various columns as given on p. 15 are repeated below:

p = height of observation code number

m = index for moving average, seconds

k = episode number

N = number of observations

$\bar{\delta}$ = mean burnout deviation, mils, for episode

$\bar{A}$ = mean wind velocity, mph, for episode

b = regression line slope, mils/mph

s_{y90} = 90% confidence limits, mils

r = correlation coefficient

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p	m	k	N	$\bar{\delta}$	$\bar{A}$	b	Sy_{90}	r	p	m	k
1	1	01	152	18 401973	28 803947	0 4963435	3 617079	8027560	1	1	01
1	1	02	224	19 934375	31 026339	0 2488983	3 140749	5287286	1	1	02
1	1	07	27	24 529629	39 962962	0 3621817	2 703825	6057524	1	1	07
1	1	08	184	23 998369	37 620108	0 2897560	4 552783	5251321	1	1	08
1	1	09	200	20 318500	30 773500	0 3988728	3 884281	6708618	1	1	09
1	1	10	155	22 876129	36 141290	0 4141997	3 604350	7527108	1	1	10
1	1	11	91	21 609890	33 173626	0 2610795	3 201217	4517304	1	1	11
1	1	16	142	18 761267	30 643661	0 3154576	3 137854	6290327	1	1	16
1	1	17	115	22 553043	35 077391	0 2490572	3 064762	4579215	1	1	17
1	1	18	114	22 219298	33 531578	0 2723082	3 776090	5396741	1	1	18
1	1	19	43	18 365116	28 067441	0 1315426	3 407965	2222203	1	1	19
1	1	20	127	22 246456	35 396062	0 3141275	2 647815	7522228	1	1	20
1	1	21	90	20 978888	32 227777	0 3991792	3 571449	6312985	1	1	21
1	1	22	93	24 375268	36 915053	0 3723326	3 199921	6726411	1	1	22
1	1	23	115	22 133043	34 770434	0 3556326	3 213422	6346594	1	1	23
1	1	24	55	22 290909	35 580000	0 2937747	4 062000	5904580	1	1	24
1	1	25	120	17 281666	28 977500	0 4257613	2 483387	7841569	1	1	25
1	1	26	116	15 011206	26 203448	0 4110421	3 147669	6606994	1	1	26
1	1	27	80	16 117500	26 157500	0 3360754	4 433399	5358526	1	1	27
1	1	28	119	17 319327	28 700000	0 5160876	3 936052	7893363	1	1	28
1	1	29	129	20 050387	32 242635	0 5367181	5 236459	7115326	1	1	29
1	1	30	77	23 925974	36 853246	0 4532567	3 244717	6904091	1	1	30
1	1	31	118	22 050000	33 775423	0 5566223	3 359854	7368206	1	1	31
1	1	32	117	19 694871	32 456410	0 3467119	2 927776	6457135	1	1	32
1	1	33	111	17 792792	29 000000	0 3110910	2 735460	6426547	1	1	33
1	1	34	38	14 471052	24 239473	0 6110296	2 686268	6466233	1	1	34
1	1	35	53	15 956603	26 696226	0 0808087-	3 616191	1185400	1	1	35
1	1	36	114	16 224561	26 524561	0 6891313	4 528609	7728484	1	1	36
1	1	37	113	21 899115	32 083185	0 3868532	3 808739	5880358	1	1	37
1	1	38	61	20 645901	32 540983	0 3802797	3 516508	5753276	1	1	38

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p	m	k	N	$\bar{\delta}$	$\bar{A}$	b	Sy_{90}	r	p	m	k
1	2	01	151	18 438410	28 857615	0 5182796	3 553698	8084899	1	2	01
1	2	02	223	19 934977	31 029596	0 2669432	3 120787	5380295	1	2	02
1	2	07	26	24 596153	40 150000	0 5669777	2 351375	7239712	1	2	07
1	2	08	183	24 021311	37 666666	0 3065019	4 511611	5338422	1	2	08
1	2	09	199	20 296984	30 794472	0 4016338	4 000336	6434189	1	2	09
1	2	10	154	22 872727	36 174675	0 4299502	3 610236	7528113	1	2	10
1	2	11	90	21 656666	33 243333	0 2917832	3 103051	4710685	1	2	11
1	2	16	141	18 763829	30 661702	0 3270586	3 150015	6285578	1	2	16
1	2	17	114	22 523684	35 075438	0 2831245	2 990733	4850075	1	2	17
1	2	18	113	22 243362	33 591150	0 2854644	3 764114	5407539	1	2	18
1	2	19	42	18 402380	28 100000	0 0784893	3 485430	1232166	1	2	19
1	2	20	126	22 273015	35 488095	0 3216400	2 651306	7490947	1	2	20
1	2	21	89	20 998876	32 255056	0 4415197	3 478812	6571905	1	2	21
1	2	22	92	24 347826	36 935869	0 4437402	2 939030	7331157	1	2	22
1	2	23	114	22 107894	34 807017	0 4012063	3 074064	6697481	1	2	23
1	2	24	54	22 429629	35 759259	0 2706983	3 989393	5503548	1	2	24
1	2	25	119	17 292436	29 015126	0 4467008	2 457125	7902319	1	2	25
1	2	26	115	14 992173	25 209565	0 4373757	3 092641	6757290	1	2	26
1	2	27	7	16 196202	26 156962	0 3624354	4 274187	5578091	1	2	27
1	2	28	118	17 325423	28 740677	0 5377464	3 876099	7980858	1	2	28
1	2	29	128	20 061718	32 249218	0 5534672	5 254697	7112711	1	2	29
1	2	30	76	23 965789	36 951315	0 4856183	3 311502	6715734	1	2	30
1	2	31	117	22 033333	33 817094	0 6018220	3 269471	7533307	1	2	31
1	2	32	116	19 683620	32 479310	0 3656026	2 925656	6479284	1	2	32
1	2	33	110	17 786363	29 089090	0 3378415	2 690161	6600850	1	2	33
1	2	34	37	14 464864	24 254054	0 8204932	2 474660	7169922	1	2	34
1	2	35	52	15 961538	26 717307	0 1341477-	3 612731	1787909	1	2	35
1	2	36	113	16 285840	26 525663	0 7523865	4 155160	8100080	1	2	36
1	2	37	112	21 914285	32 082142	0 4316750	3 738796	6088897	1	2	37
1	2	38	60	20 561666	32 455000	0 3962969	3 446657	5670305	1	2	38

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p	m	k	N	$\bar{\delta}$	$\bar{A}$	b	Sy_{90}	r	p	m	k
1	4	01	149	18 510067	28 891275	0 5378935	3 603124	7986069	1	4	01
1	4	02	221	19 934841	31 003619	0 2797660	3 168851	5201446	1	4	02
1	4	07	24	24 579166	40 300000	0 8500091	1 784851	8582992	1	4	07
1	4	08	181	24 050828	37 707734	0 3127410	4 594041	5078239	1	4	08
1	4	09	197	20 244162	30 757360	0 4078854	4 041022	6238836	1	4	09
1	4	10	152	22 869078	36 163157	0 4410099	3 714187	7387583	1	4	10
1	4	11	88	21 718181	33 275000	0 3418285	3 029195	4960701	1	4	11
1	4	16	139	18 758273	30 642446	0 3329951	3 257057	5987934	1	4	16
1	4	17	112	22 467857	35 026795	0 3452217	2 881106	5205151	1	4	17
1	4	18	111	22 290990	33 618918	0 2959241	3 803744	5242754	1	4	18
1	4	19	40	18 460000	28 102500	0 0606041-	3 508688	0831646	1	4	19
1	4	20	124	22 331451	35 599193	0 3141569	2 786480	7084947	1	4	20
1	4	21	87	21 051724	32 252873	0 5009927	3 440615	6661445	1	4	21
1	4	22	90	24 294444	36 863333	0 5283344	2 742744	7710487	1	4	22
1	4	23	112	22 062500	34 821428	0 4612955	2 972132	6932569	1	4	23
1	4	24	52	22 467307	35 968461	0 2523129	4 278557	4690056	1	4	24
1	4	25	117	17 306637	29 028205	0 4770931	2 512287	7816312	1	4	25
1	4	26	113	14 933628	26 184955	0 4555805	3 086575	6691856	1	4	26
1	4	27	77	16 361038	26 083116	0 3967564	3 944849	5981736	1	4	27
1	4	28	116	17 293965	28 750862	0 5572912	3 910603	7963009	1	4	28
1	4	29	126	20 106349	32 234126	0 5729306	5 382985	6969398	1	4	29
1	4	30	74	24 012162	37 140540	0 5358190	3 545396	6122177	1	4	30
1	4	31	115	21 970434	33 828695	0 6564119	3 119676	7748092	1	4	31
1	4	32	114	19 683333	32 471052	0 3876673	3 004115	6299101	1	4	32
1	4	33	108	17 769444	29 169444	0 3758067	2 645683	6774202	1	4	33
1	4	34	35	14 405714	24 202857	1 0540505	2 477904	7210924	1	4	34
1	4	35	50	16 014000	26 640000	0 1609099-	3 615880	1947797	1	4	35
1	4	36	111	16 424324	26 482882	0 8499064	3 381152	8730851	1	4	36
1	4	37	110	21 967272	32 087272	0 4842654	3 704077	6161985	1	4	37
1	4	38	58	20 403448	32 241379	0 3778154	3 475140	4918028	1	4	38

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p	m	k	N	$\bar{\delta}$	$\bar{A}$	b	Sy_{90}	r	p	m	k
1	8	01	145	18 666895	29 008965	0 5350074	3 848566	7529897	1	8	01
1	8	02	217	19 943317	30 967741	0 2805318	3 298822	4627271	1	8	02
1	8	07				0 0000000	0 000000	0000000	1	8	07
1	8	08	177	24 068361	37 819774	0 2916326	4 894188	4151520	1	8	08
1	8	09	193	20 142487	30 633160	0 3908868	4 199312	5594390	1	8	09
1	8	10	140	22 906756	36 198648	0 4488054	3 890916	7141287	1	8	10
1	8	11	84	21 735714	33 263095	0 4182392	3 038317	5005269	1	8	11
1	8	16	135	18 735555	30 583703	0 3355646	3 475931	5313945	1	8	16
1	8	17	108	22 391666	35 084259	0 4418463	2 778338	5513185	1	8	17
1	8	18	107	22 410280	33 632710	0 2632752	4 000968	4200011	1	8	18
1	8	19	36	18 694444	28 077777	0 3067476-	3 229220	3201745	1	8	19
1	8	20	120	22 459166	35 885833	0 2868847	3 009199	6141147	1	8	20
1	8	21	83	21 106024	32 204819	0 5691964	3 512112	6625357	1	8	21
1	8	22	86	24 243023	36 673255	0 5659488	3 181029	6784269	1	8	22
1	8	23	108	21 931481	34 863888	0 5684041	2 797168	7147729	1	8	23
1	8	24	48	22 477083	36 337500	0 2119164	4 734178	3056662	1	8	24
1	8	25	113	17 285840	29 032743	0 5277324	2 645797	7593553	1	8	25
1	8	26	109	14 844036	26 142201	0 4516831	3 188634	6366686	1	8	26
1	8	27	73	15 697260	25 968493	0 4439299	3 232244	6805529	1	8	27
1	8	28	112	17 164285	28 764285	0 5646196	4 074514	7757029	1	8	28
1	8	29	122	20 191803	32 101639	0 6161801	5 701459	6588492	1	8	29
1	8	30	70	23 927142	37 427142	0 7766640	3 482477	6398907	1	8	30
1	8	31	111	21 891891	33 792792	0 7597677	3 012352	7940939	1	8	31
1	8	32	110	19 721818	32 509090	0 4461934	3 052721	6205204	1	8	32
1	8	33	104	17 746153	29 244230	0 4324371	2 624251	6897394	1	8	33
1	8	34	31	14 161290	24 177419	1 1778316	2 788098	6227726	1	8	34
1	8	35	46	16 067391	26 439130	0 2586507-	3 601757	2554539	1	8	35
1	8	36	107	16 671952	26 357943	0 9860211	2 503580	9278645	1	8	36
1	8	37	106	21 959433	32 165094	0 5900137	3 566003	6571454	1	8	37
1	8	38	54	20 244444	32 140740	0 2656284	3 779530	3044165	1	8	38

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p	m	k	N	$\bar{\delta}$	$\bar{A}$	b	Sy_{90}	r	p	m	k
2	1	01	152	18 401973	30 997368	0 4635156	3 186203	8509333	2	1	01
2	1	02	224	19 934375	33 412946	0 3059812	2 954957	6018881	2	1	02
2	1	03	245	24 051020	39 126122	0 3898441	3 746775	6227334	2	1	03
2	1	04	161	23 554037	38 726086	0 4053040	2 555044	8402051	2	1	04
2	1	05	231	24 049783	39 477922	0 4198410	3 118592	7870042	2	1	05
2	1	06	58	20 656896	34 513793	0 5140887	2 211185	7597477	2	1	06
2	1	07	195	25 320512	41 769743	0 3935244	3 019136	7028496	2	1	07
2	1	08	184	23 998369	40 243478	0 3660894	3 649816	7311327	2	1	08
2	1	09	200	20 318500	32 824000	0 4083720	3 634087	7201528	2	1	09
2	1	10	155	22 876129	38 451612	0 4202415	3 160501	8165507	2	1	10
2	1	11	91	21 609890	36 024175	0 3537862	3 086002	5682772	2	1	11
2	1	16	142	18 761267	31 261971	0 3485456	2 726429	7374043	2	1	16
2	1	17	115	22 553043	37 320869	0 3823910	2 729150	6109853	2	1	17
2	1	18	114	22 219298	37 477192	0 3158140	3 323900	6714401	2	1	18
2	1	19	43	18 365116	30 316279	0 3602923	2 638798	6557905	2	1	19
2	1	20	127	22 246456	37 648031	0 3453788	2 328210	8150610	2	1	20
2	1	21	90	20 978888	34 215555	0 4338658	2 457708	8456795	2	1	21
2	1	22	93	24 375268	39 550537	0 4709212	2 424973	8278560	2	1	22
2	1	23	115	22 133043	35 834782	0 4024683	3 028449	6652497	2	1	23
2	1	24	55	22 290909	37 680000	0 3163873	3 862785	6410648	2	1	24
2	1	25	120	17 281666	28 603333	0 4121933	2 614387	7571013	2	1	25
2	1	26	115	15 011206	26 121551	0 4000587	3 069553	6813314	2	1	26
2	1	27	80	16 117500	25 383750	0 3426612	4 093162	6263827	2	1	27
2	1	28	119	17 319327	28 831932	0 5268018	3 009227	8829903	2	1	28
2	1	29	129	20 050387	31 644186	0 5069095	4 664981	7798476	2	1	29
2	1	30	77	23 925974	36 906493	0 3901990	2 964754	7503854	2	1	30
2	1	31	118	22 050000	33 136440	0 4912793	3 065236	7871171	2	1	31
2	1	32	117	19 694871	32 053846	0 3876665	2 617912	7306377	2	1	32
2	1	33	111	17 792792	29 210810	0 2707952	2 649776	6702255	2	1	33
2	1	34	38	14 471052	23 955263	0 4068766	2 248419	7708208	2	1	34
2	1	35	53	15 956603	25 926415	0 2309426	3 422155	3420826	2	1	35
2	1	36	114	16 224561	25 151754	0 6204667	3 975192	8304852	2	1	36
2	1	37	113	21 899115	32 983185	0 3957636	3 461746	6779084	2	1	37
2	1	38	61	20 645901	32 937704	0 3797544	2 996935	7170005	2	1	38

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p	m	k	N	$\bar{\delta}$	$\bar{A}$	b	Sy_{30}	r	p	m	k
2	2	01	151	18 438410	31 043046	0 4809358	3 157600	8523853	2	2	01
2	2	02	223	19 934977	33 421973	0 3279987	2 921077	6144132	2	2	02
2	2	03	244	24 085655	39 155327	0 4160927	3 701471	6186603	2	2	03
2	2	04	160	23 546875	38 779375	0 4240476	2 520510	8453205	2	2	04
2	2	05	230	24 053913	39 490434	0 4420268	3 102449	7900917	2	2	05
2	2	06	57	20 619298	34 543859	0 6218082	935469	8161744	2	2	06
2	2	07	194	25 331958	41 803092	0 4369504	2 981406	7114289	2	2	07
2	2	08	183	24 021311	40 284699	0 3871835	3 634174	7321613	2	2	08
2	2	09	199	20 296984	32 759296	0 4009012	3 647103	7161769	2	2	09
2	2	10	154	22 872727	38 479870	0 4351050	3 135843	8204331	2	2	10
2	2	11	90	21 556666	36 067777	0 4220395	2 905242	6151571	2	2	11
2	2	16	141	18 763829	31 292198	0 3723087	2 659478	7541994	2	2	16
2	2	17	114	22 523684	37 326315	0 4239489	2 641875	6350129	2	2	17
2	2	18	113	22 243362	37 539823	0 3346973	3 287443	6784384	2	2	18
2	2	19	42	18 402380	30 371428	0 4025715	2 696260	6408269	2	2	19
2	2	20	126	22 273015	37 723809	0 3552200	2 302953	8178564	2	2	20
2	2	21	89	20 998876	34 243820	0 4697666	2 210110	8778991	2	2	21
2	2	22	92	24 347826	39 532608	0 5241773	2 148072	8677088	2	2	22
2	2	23	114	22 107894	35 846491	0 4647615	2 638800	7278310	2	2	23
2	2	24	54	22 429629	37 712962	0 2939949	3 617717	6013294	2	2	24
2	2	25	119	17 292436	28 626890	0 4433407	2 521974	7774204	2	2	25
2	2	26	115	14 992173	26 140000	0 4272750	3 000356	6989675	2	2	26
2	2	27	79	16 196202	25 392405	0 3567345	3 998380	6302251	2	2	27
2	2	28	118	17 325423	28 855932	0 5502440	2 828345	8981598	2	2	28
2	2	29	128	20 061718	31 667187	0 5254906	4 639443	7841149	2	2	29
2	2	30	76	23 965789	37 053947	0 4167282	2 971697	7469255	2	2	30
2	2	31	117	22 033333	33 147863	0 5310381	2 936951	8068498	2	2	31
2	2	32	116	19 583620	32 050000	0 4082740	2 608483	7340230	2	2	32
2	2	33	110	17 786363	29 277272	0 2861115	2 641695	6751752	2	2	33
2	2	34	37	14 464864	23 870270	0 4302011	2 284455	7654676	2	2	34
2	2	35	52	15 961538	26 013461	0 2414822	3 495813	3059556	2	2	35
2	2	36	113	16 285840	25 152212	0 6655078	3 566844	8640595	2	2	36
2	2	37	112	21 914285	32 994642	0 4362310	3 374119	6982213	2	2	37
2	2	38	60	20 561666	32 851666	0 4001790	2 872944	7270463	2	2	38

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IBM SERVICE BUREAU COMPUTATION RESULTS FOR UNIVERSITY OF MICHIGAN WIND DATA

p	m	k	N	$\bar{\delta}$	$\bar{A}$	b	Sy_{90}	r	p	m	k
2	4	01	149	18 510067	31 095973	0 4988454	3 287800	8357025	2	4	01
2	4	02	221	19 934841	33 378280	0 3518793	2 934720	6118490	2	4	02
2	4	03	242	24 143801	39 163636	0 4359041	3 732718	5851275	2	4	03
2	4	04	158	23 522784	38 817088	0 4405418	2 621585	8311664	2	4	04
2	4	05	228	24 060087	39 453508	0 4598256	3 248318	7685737	2	4	05
2	4	06	55	20 560000	34 549090	0 6830247	1 881979	8281503	2	4	06
2	4	07	192	25 352500	41 823958	0 4799025	3 157141	6658968	2	4	07
2	4	08	181	24 050828	40 323756	0 3927135	3 849068	6921376	2	4	08
2	4	09	197	20 244162	32 734517	0 4022761	3 793767	6794745	2	4	09
2	4	10	152	22 869078	38 471052	0 4375162	3 354008	7934672	2	4	10
2	4	11	88	21 718181	36 093181	0 5442931	2 690261	6782240	2	4	11
2	4	16	139	18 758273	31 279856	0 4018777	2 679419	7522624	2	4	16
2	4	17	112	22 467857	37 309821	0 4657251	2 619546	6303194	2	4	17
2	4	18	111	22 290990	37 563063	0 3351419	3 436673	6388006	2	4	18
2	4	19	40	18 460000	30 475000	0 3711606	3 069489	4898713	2	4	19
2	4	20	124	22 331451	37 870967	0 3579601	2 399803	7941021	2	4	20
2	4	21	87	21 051724	34 250574	0 5051583	2 041995	8966977	2	4	21
2	4	22	90	24 294444	39 407777	0 5991501	1 957038	8908178	2	4	22
2	4	23	112	22 062500	35 871428	0 5192537	2 769871	7408725	2	4	23
2	4	24	52	22 467307	37 803846	0 2665069	4 230182	4873451	2	4	24
2	4	25	117	17 306837	28 643589	0 4890441	2 454956	7927807	2	4	25
2	4	26	113	14 933628	26 129203	0 4463666	2 971088	6983261	2	4	26
2	4	27	77	16 361038	25 380519	0 3742794	3 756496	6462755	2	4	27
2	4	28	116	17 293965	28 853448	0 5714367	2 747891	9051700	2	4	28
2	4	29	126	20 106349	31 568688	0 5369964	4 859133	7622002	2	4	29
2	4	30	74	24 012162	37 356756	0 4813322	3 181781	7046085	2	4	30
2	4	31	115	21 970434	33 106956	0 5638627	2 899588	8091553	2	4	31
2	4	32	114	19 683333	32 011403	0 4310548	2 682145	7203262	2	4	32
2	4	33	108	17 769444	29 342592	0 3043156	2 662010	6724573	2	4	33
2	4	34	35	14 405714	23 788571	0 4175486	2 539234	7042145	2	4	34
2	4	35	50	16 014000	26 108000	0 2176007	3 612586	1992261	2	4	35
2	4	36	111	16 424324	25 078378	0 7159800	3 139279	8915683	2	4	36
2	4	37	110	21 967272	32 985454	0 4857708	3 350251	7013167	2	4	37
2	4	38	58	20 403448	32 613793	0 3835760	2 982927	6643957	2	4	38

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p	m	k	N	$\bar{\delta}$	$\bar{A}$	b	Sy_{90}	r	p	m	k
2	8	01	145	18 666896	31 237241	0 4969657	3 620908	7853066	2	8	01
2	8	02	217	19 943317	33 345161	0 3642909	3 060330	5688950	2	8	02
2	8	03	238	24 249579	39 180672	0 4694686	3 750923	5312583	2	8	03
2	8	04	154	23 479870	38 827272	0 4540936	2 855518	7967023	2	8	04
2	8	05	224	24 056250	39 417410	0 4710615	3 591139	7112844	2	8	05
2	8	06	51	20 317647	34 556862	0 6716538	1 828395	8029291	2	8	06
2	8	07	188	25 354255	41 886170	0 5603186	3 336447	6173571	2	8	07
2	8	08	177	24 068361	40 410734	0 3896130	4 237473	6160856	2	8	08
2	8	09	193	20 142487	32 579792	0 3946250	3 987806	6167949	2	8	09
2	8	10	148	22 906756	38 502027	0 4327364	3 758625	7367053	2	8	10
2	8	11	84	21 735714	36 122619	0 6987770	2 637216	6991970	2	8	11
2	8	16	135	18 735555	31 280000	0 4281034	2 929063	7003024	2	8	16
2	8	17	108	22 391666	37 344444	0 5840903	2 507894	6579240	2	8	17
2	8	18	107	22 410280	37 546728	0 2837854	3 811814	5024287	2	8	18
2	8	19	36	18 694444	30 652777	0 2252635	3 340046	1996292	2	8	19
2	8	20	120	22 459166	38 234166	0 3572699	2 600790	7312551	2	8	20
2	8	21	83	21 106024	34 289156	0 5099301	2 339323	8666546	2	8	21
2	8	22	86	24 243023	39 287209	0 6340348	2 614855	7970538	2	8	22
2	8	23	108	21 931481	35 865740	0 5851600	2 678788	7425787	2	8	23
2	8	24	48	22 477083	38 139583	0 2055174	4 785669	2713005	2	8	24
2	8	25	113	17 285840	28 674336	0 5331248	2 584746	7719676	2	8	25
2	8	26	109	14 844036	26 129357	0 4669253	3 027223	6811951	2	8	26
2	8	27	73	15 597260	25 438356	0 3976613	3 142345	7018547	2	8	27
2	8	28	112	17 164285	28 838392	0 5751899	2 916501	8921524	2	8	28
2	8	29	122	20 191803	31 416393	0 5688000	5 340520	7095538	2	8	29
2	8	30	70	23 927142	37 782857	0 7857142	2 953952	7583581	2	8	30
2	8	31	111	21 891891	32 997297	0 6244842	2 901552	8107163	2	8	31
2	8	32	110	19 721818	32 032727	0 4837515	2 733994	7118662	2	8	32
2	8	33	104	17 746153	29 413461	0 3358461	2 728877	6581064	2	8	33
2	8	34	31	14 161290	23 600000	0 4104406	2 836379	6053602	2	8	34
2	8	35	46	16 067391	26 160869	0 3397534	3 648731	2017818	2	8	35
2	8	36	107	16 671962	25 015887	0 7825546	2 940440	8989802	2	8	36
2	8	37	106	21 959433	32 964150	0 5497245	3 411836	6927510	2	8	37
2	8	38	54	20 244444	32 316666	0 2492866	3 650231	3920305	2	8	38

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p	m	k	N	$\bar{\delta}$	$\bar{A}$	b	Sy_{90}	r	p	m	k
3	1	01	152	18 401973	30 903947	0 4270080	2 544606	9077550	3	1	01
3	1	02	224	19 934375	33 126785	0 3467764	2 477168	7428504	3	1	02
3	1	03	245	24 051020	40 423673	0 4255055	3 019750	7760995	3	1	03
3	1	04	161	23 554037	40 167080	0 4927756	2 353942	8662633	3	1	04
3	1	05	231	24 049783	40 754112	0 4553870	2 408266	8792154	3	1	05
3	1	06	58	20 656896	34 179310	0 3509391	2 236219	7533852	3	1	06
3	1	07	195	25 320512	42 693333	0 4059615	2 670056	7773312	3	1	07
3	1	08	184	23 998369	39 780978	0 3771390	3 236143	7962938	3	1	08
3	1	09	200	20 318500	32 823500	0 3862716	3 139789	8004161	3	1	09
3	1	10	155	22 876129	38 009677	0 4203521	2 556149	8843169	3	1	10
3	1	11	91	21 609890	34 945054	0 3941240	2 522301	7400657	3	1	11
3	1	16	142	18 751267	31 676760	0 4792330	2 490242	7870118	3	1	16
3	1	17	115	22 553043	37 095652	0 3916613	2 309747	7423736	3	1	17
3	1	18	114	22 219298	37 669298	0 4025035	2 701214	7983212	3	1	18
3	1	19	43	18 365116	29 616279	0 3215572	2 774404	6082588	3	1	19
3	1	20	127	22 246456	38 232283	0 4433539	2 245359	8291632	3	1	20
3	1	21	90	20 978888	34 563333	0 4341507	2 205784	8778227	3	1	21
3	1	22	93	24 375268	41 065591	0 4213862	2 222426	8577376	3	1	22
3	1	23	115	22 133043	36 474782	0 3673830	2 752645	7495213	3	1	23
3	1	24	55	22 290909	36 865454	0 4550088	2 781240	8334484	3	1	24

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IBM SERVICE BUREAU COMPUTATION RESULTS FOR UNIVERSITY OF MICHIGAN WIND DATA

p	m	k	N	$\bar{\delta}$	$\bar{A}$	b	Sy_{90}	r	p	m	k
3	2	01	151	18 438410	30 939735	0 4381211	2 418930	9162588	3	2	01
3	2	02	223	19 934977	33 133632	0 3924192	2 303742	7828251	3	2	02
3	2	03	244	24 085655	40 471721	0 4691025	2 830285	7994412	3	2	03
3	2	04	160	23 546875	40 188750	0 5426682	1 951696	9104174	3	2	04
3	2	05	230	24 053913	40 773043	0 4820975	2 251188	8956325	3	2	05
3	2	06	57	20 619298	34 245614	0 3922975	2 090421	7838092	3	2	06
3	2	07	194	25 331958	42 752061	0 4484778	2 599112	7903575	3	2	07
3	2	08	183	24 021311	39 836612	0 4113670	3 039084	8219239	3	2	08
3	2	09	199	20 296984	32 814070	0 3996285	3 326262	7712587	3	2	09
3	2	10	154	22 872727	38 020779	0 4414747	2 410628	8982339	3	2	10
3	2	11	90	21 656666	35 027777	0 4432936	2 292337	7829549	3	2	11
3	2	16	141	18 763829	31 702127	0 5425953	2 286477	8253998	3	2	16
3	2	17	114	22 523684	37 091228	0 4422892	2 118805	7849553	3	2	17
3	2	18	113	22 243362	37 707964	0 4393223	2 526487	8253623	3	2	18
3	2	19	42	18 402380	29 769047	0 4163633	2 560140	6845891	3	2	19
3	2	20	126	22 273015	38 311111	0 4812128	2 091990	8525102	3	2	20
3	2	21	89	20 998876	34 602247	0 4529769	2 082649	8924078	3	2	21
3	2	22	92	24 347826	41 057608	0 4404827	2 150597	8673738	3	2	22
3	2	23	114	22 107894	36 491228	0 3912455	2 692551	7595680	3	2	23
3	2	24	54	22 429629	36 840740	0 4713732	2 577144	8420723	3	2	24

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IBM SERVICE BUREAU COMPUTATION RESULTS FOR UNIVERSITY OF MICHIGAN WIND DATA

p	m	k	N	$\bar{\delta}$		$\bar{A}$		b		Sy_{90}		r	p	m	k
3	4	01	149	18	510067	30	964429	0	4377103	2	596173	9010788	3	4	01
3	4	02	221	19	934841	33	102262	0	4429927	2	247798	7955916	3	4	02
3	4	03	242	24	143801	40	507024	0	5204809	2	831200	7884461	3	4	03
3	4	04	158	23	522784	40	172784	0	5894528	1	640436	9375215	3	4	04
3	4	05	228	24	060087	40	768421	0	5014784	2	365999	8847916	3	4	05
3	4	06	55	20	560000	34	292727	0	4223245	2	096735	7810516	3	4	06
3	4	07	192	25	362500	42	796875	0	4798105	2	770134	7559819	3	4	07
3	4	08	181	24	050826	39	875690	0	4462753	3	037565	8219256	3	4	08
3	4	09	197	20	244162	32	717258	0	4123475	3	506539	7349232	3	4	09
3	4	10	152	22	869078	37	990789	0	4596477	2	505966	8906301	3	4	10
3	4	11	88	21	718181	35	126136	0	4864582	2	315696	7745266	3	4	11
3	4	16	139	18	758273	31	694964	0	6393724	2	086912	8582842	3	4	16
3	4	17	112	22	467857	37	074107	0	5123763	1	919800	8223672	3	4	17
3	4	18	111	22	290990	37	685585	0	4623746	2	625515	8090228	3	4	18
3	4	19	40	18	460000	29	947500	0	5793296	2	227411	7744558	3	4	19
3	4	20	124	22	331451	38	402419	0	5161982	1	990335	8636565	3	4	20
3	4	21	87	21	051724	34	577011	0	4694172	2	049132	8959324	3	4	21
3	4	22	90	24	294444	40	991111	0	4410437	2	484916	8168029	3	4	22
3	4	23	112	22	062500	36	466964	0	4259549	2	692659	7574241	3	4	23
3	4	24	52	22	467307	36	705769	0	5426938	2	820658	8130094	3	4	24

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IBM SERVICE BUREAU COMPUTATION RESULTS FOR UNIVERSITY OF MICHIGAN WIND DATA

p	m	k	N	$\bar{\delta}$		$\bar{A}$		b		Sy_{90}		r	p	m	k
3	8	01	145	18	666896	31	064137	0	4103347	3	268372	8292823	3	8	01
3	8	02	217	19	943317	33	047004	0	4841931	2	486760	7439157	3	8	02
3	8	03	238	24	249579	40	554621	0	5743729	3	025871	7300026	3	8	03
3	8	04	154	23	479870	40	198701	0	6106229	2	025165	9034794	3	8	04
3	8	05	224	24	056250	40	733928	0	5132000	2	839741	8312954	3	8	05
3	8	06	51	20	317647	34	266666	0	4083817	2	254410	6745461	3	8	06
3	8	07	188	25	354255	42	858510	0	5463842	2	958068	7166124	3	8	07
3	8	08	177	24	068361	39	950847	0	4789867	3	325154	7861047	3	8	08
3	8	09	193	20	142487	32	524352	0	4276919	3	783680	6650118	3	8	09
3	8	10	148	22	906756	37	987837	0	4809633	2	775267	8664302	3	8	10
3	8	11	84	21	735714	35	276190	0	5507070	2	494847	7365954	3	8	11
3	8	16	135	18	735555	31	720000	0	7592762	1	751041	9043703	3	8	16
3	8	17	108	22	391666	37	064814	0	5996420	1	811547	8390973	3	8	17
3	8	18	107	22	410280	37	682242	0	4454284	3	040868	7240453	3	8	18
3	8	19	36	18	694444	30	250000	0	7134125	2	439529	6984219	3	8	19
3	8	20	120	22	459166	38	580000	0	5256860	2	117994	8315285	3	8	20
3	8	21	83	21	106024	34	607228	0	4794133	2	423976	8560079	3	8	21
3	8	22	86	24	243023	40	933720	0	4000976	3	391640	6216327	3	8	22
3	8	23	108	21	931481	36	431481	0	4744592	2	680866	7421054	3	8	23
3	8	23	108	21	931481	36	431481	0	4744592	2	680866	7421054	3	8	23
3	8	24	48	22	477083	36	729166	0	6465799	3	519262	7064143	3	8	24

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IBM SERVICE BUREAU COMPUTATION RESULTS FOR UNIVERSITY OF MICHIGAN WIND DATA

p	m	k	N	$\bar{\delta}$	$\bar{A}$	b	Sy_{30}	r	p	m	k
4	1	01	152	18 401973	31 490131	0 4901420	2 206660	9314820	4	1	01
4	1	02	224	19 934375	34 063839	0 4526163	2 253706	7931191	4	1	02
4	1	03				0 0000000	0 000000	0000000	4	1	03
4	1	04	161	23 554037	40 262111	0 4820339	2 503823	8471225	4	1	04
4	1	05	231.	24 049783	41 167532	0 5054607	2 442980	8754592	4	1	05
4	1	06	58	20 656896	35 362068	0 4888948	1 697963	8664287	4	1	06
4	1	07	195	25 320512	43 434358	0 4455650	2 525188	8037558	4	1	07
4	1	08	184	23 998369	41 303260	0 4212529	2 720802	8610143	4	1	08
4	1	09	200	20 318500	35 309000	0 4251178	2 669370	8603919	4	1	09
4	1	10	155	22 876129	39 373548	0 5061133	2 447308	8945304	4	1	10
4	1	11	91	21 609890	36 919780	0 3833153	2 359799	7772386	4	1	11
4	1	16	142	18 761267	31 444366	0 4309898	2 438803	7968368	4	1	16
4	1	17	115	22 553043	38 469565	0 4403473	1 996696	8151999	4	1	17
4	1	18	114	22 219298	37 617543	0 4711264	2 390585	8461294	4	1	18
4	1	19	43	18 365116	32 495348	0 3661346	2 102088	7989528	4	1	19
4	1	20	127	22 246456	38 674015	0 5837211	2 046153	8606570	4	1	20
4	1	21	90	20 978888	36 522222	0 5202866	2 164689	8803067	4	1	21
4	1	22	93	24 375258	42 569892	0 5610894	1 887425	8996577	4	1	22
4	1	23	115	22 133043	37 895652	0 3945969	2 313433	8309450	4	1	23
4	1	24	55	22 290909	38 416363	0 3745160	3 396765	7379142	4	1	24
4	1	25	120	17 281666	29 493333	0 4633137	2 186508	8375395	4	1	25
4	1	26	116	15 011206	25 849137	0 4945477	1 855422	8962934	4	1	26
4	1	27	80	16 117500	27 748750	0 3573365	2 797291	8462881	4	1	27
4	1	28	119	17 319327	31 026050	0 4782916	2 307019	9330071	4	1	28
4	1	29	129	20 050387	34 880620	0 4949917	2 423706	9456369	4	1	29
4	1	30	77	23 925974	42 305194	0 5297366	2 158878	8765405	4	1	30
4	1	31	118	22 050000	38 305932	0 4080137	2 255393	8910820	4	1	31
4	1	32	117	19 694871	33 326495	0 4086150	2 101695	8363911	4	1	32
4	1	33	111	17 792792	32 263963	0 3825140	2 278508	7698942	4	1	33
4	1	34	38	14 471052	25 447368	0 4165706	2 040349	8159667	4	1	34
4	1	35	53	15 956603	29 066037	0 4163121	2 057497	8251208	4	1	35
4	1	36	114	16 224561	29 391228	0 5429738	2 589384	9318482	4	1	36
4	1	37	113	21 899115	38 435398	0 4012159	2 169773	8875148	4	1	37
4	1	38	61	20 645901	35 460655	0 4495469	1 915196	8952992	4	1	38

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p	m	k	N	$\bar{\delta}$	$\bar{A}$	b	Sy_{90}	r	p	m	k
4	2	01	151	18 438419	31 528476	0 5048247	1 984494	9444546	4	2	01
4	2	02	223	19 934977	34 079372	0 5022523	2 133721	8172248	4	2	02
4	2	03				0 0000000	0 000000	0000000	4	2	03
4	2	04	160	23 546875	40 279375	0 5067333	2 443355	8554380	4	2	04
4	2	05	230	24 053913	41 189130	0 5276479	2 352559	8854032	4	2	05
4	2	06	57	20 619298	35 342105	0 5226144	1 626056	8755912	4	2	06
4	2	07	194	25 331958	43 493814	0 4881729	2 471586	8127687	4	2	07
4	2	08	183	24 021311	41 389071	0 4391079	2 681457	8645370	4	2	08
4	2	09	199	20 296984	35 309045	0 4508012	2 884349	8338731	4	2	09
4	2	10	154	22 872727	39 401948	0 5302539	2 297237	9080583	4	2	10
4	2	11	90	21 656666	36 991111	0 3857438	2 403262	7580589	4	2	11
4	2	16	141	18 763829	31 469503	0 4591571	2 370963	8107381	4	2	16
4	2	17	114	22 523684	38 468421	0 4550786	2 002621	8106151	4	2	17
4	2	18	113	22 243362	37 631858	0 4964602	2 303077	8573841	4	2	18
4	2	19	42	18 402380	32 626190	0 3988495	1 990201	8239554	4	2	19
4	2	20	126	22 273015	38 731746	0 6174670	1 910365	8787246	4	2	20
4	2	21	89	20 998876	36 525842	0 5505953	2 071839	8935882	4	2	21
4	2	22	92	24 347826	42 550000	0 5778270	2 036914	8819460	4	2	22
4	2	23	114	22 107894	37 893659	0 4125077	2 260998	8376681	4	2	23
4	2	24	54	22 429629	38 283333	0 4335126	2 446450	8589734	4	2	24
4	2	25	119	17 292436	29 547056	0 4946405	2 047101	8598493	4	2	25
4	2	26	115	14 992173	25 904347	0 5254895	1 701596	9140570	4	2	26
4	2	27	79	16 196202	27 841772	0 3649320	2 754780	8448977	4	2	27
4	2	26	118	17 325423	31 050847	0 4904443	2 169763	9414001	4	2	28
4	2	29	128	20 061718	34 866406	0 5063607	2 311401	9509988	4	2	29
4	2	30	76	23 965789	42 457894	0 6018986	1 794376	9158652	4	2	30
4	2	31	117	22 033333	38 325641	0 4228057	2 172584	8994581	4	2	31
4	2	32	116	19 683620	33 326724	0 4388864	1 924458	8654258	4	2	32
4	2	33	110	17 786363	32 272727	0 4344093	2 124835	8049585	4	2	33
4	2	34	37	14 464864	25 313513	0 4850246	1 887058	8470471	4	2	34
4	2	35	52	15 961538	29 190384	0 4698883	1 978222	8424678	4	2	35
4	2	36	113	16 285840	29 427433	0 5655745	2 411357	9403114	4	2	36
4	2	37	112	21 914285	38 462500	0 4171492	2 189874	8855090	4	2	37
4	2	38	60	20 561666	35 343333	0 4645083	1 932488	8869664	4	2	38

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IBM SERVICE BUREAU COMPUTATION RESULTS FOR UNIVERSITY OF MICHIGAN WIND DATA

p	m	k	N	$\bar{\delta}$	$\bar{A}$	b	$S_{y_{90}}$	r	p	m	k
4	4	01	149	18 510067	31 560402	0 5174091	1 929659	9466297	4	4	01
4	4	02	221	19 934841	34 067873	0 5538885	2 154684	8140913	4	4	02
4	4	03				0 0000000	0 000000	0000000	4	4	03
4	4	04	158	23 522784	40 270253	0 5214364	2 607785	8331170	4	4	04
4	4	05	228	24 060087	41 188157	0 5385977	2 540298	8658432	4	4	05
4	4	06	55	20 560000	35 378181	0 5937201	1 641194	8723994	4	4	06
4	4	07	192	25 362500	43 538020	0 5247668	2 713288	7674075	4	4	07
4	4	08	181	24 050828	41 476795	0 4574845	2 803117	8507120	4	4	08
4	4	09	197	20 244162	35 206091	0 4916936	3 027850	8106189	4	4	09
4	4	10	152	22 869078	39 381578	0 5556894	2 322905	9068235	4	4	10
4	4	11	88	21 718181	37 114772	0 4155208	2 535086	7214480	4	4	11
4	4	16	139	18 758273	31 459712	0 4941054	2 394908	8082039	4	4	16
4	4	17	112	22 467857	38 447321	0 4567062	2 135321	7742910	4	4	17
4	4	18	111	22 290990	37 608108	0 5177371	2 439133	8177516	4	4	18
4	4	19	40	18 460000	32 897500	0 4554642	1 641618	8522938	4	4	19
4	4	20	124	22 331451	38 754032	0 6560733	1 611690	8884946	4	4	20
4	4	21	87	21 051724	36 510344	0 5894949	2 022497	8907717	4	4	21
4	4	22	90	24 294444	42 467777	0 5654906	2 660020	7865157	4	4	22
4	4	23	112	22 062500	37 844642	0 4348999	2 324467	6260185	4	4	23
4	4	24	52	22 467307	37 965384	0 4916264	2 147793	8963460	4	4	24
4	4	25	117	17 306837	29 578632	0 5221825	2 081896	8560548	4	4	25
4	4	26	113	14 933628	25 924778	0 5488563	1 730118	9091232	4	4	26
4	4	27	77	16 361038	27 950649	0 3616097	2 947585	6009137	4	4	27
4	4	28	116	17 293965	31 042241	0 5034272	2 070256	9473353	4	4	28
4	4	29	126	20 106349	34 828571	0 5169679	2 430791	9461140	4	4	29
4	4	30	74	24 012162	42 579729	0 6711389	1 617755	9326473	4	4	30
4	4	31	115	21 97 434	38 267826	0 4248445	2 359670	8782609	4	4	31
4	4	32	114	19 683333	33 313157	0 4703629	1 891419	8722853	4	4	32
4	4	33	108	17 769444	32 193518	0 4951657	2 009232	8294103	4	4	33
4	4	34	35	14 405714	25 140000	0 5765864	1 567474	8988403	4	4	34
4	4	35	50	16 014000	29 358000	0 5217631	2 079487	8257173	4	4	35
4	4	36	111	16 424324	29 418918	0 6054393	2 313812	5426950	4	4	36
4	4	37	110	21 967272	38 476363	0 4217057	2 532093	8426932	4	4	37
4	4	38	58	20 403448	35 105172	0 4707102	2 207319	8331480	4	4	38

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p	m	k	N	$\bar{\delta}$	$\bar{A}$	b	Sy_{90}	r	p	m	k
4	8	01	145	18 666896	31 628275	0 5175871	2 314577	9183587	4	8	01
4	8	02	217	19 943317	34 026728	0 5851663	2 483327	7447434	4	8	02
4	8	03	238	24 249579	41 650840	0 5280562	2 603493	8088295	4	8	03
4	8	04	154	23 479870	40 200000	0 5230676	3 073841	7594378	4	8	04
4	8	05	224	24 056250	41 175446	0 5390662	3 034916	8044406	4	8	05
4	8	06	51	20 317647	35 462745	0 7453759	1 411349	6878603	4	8	06
4	8	07	188	25 354255	43 587765	0 6056757	2 887695	7324004	4	8	07
4	8	08	177	24 068361	41 571751	0 4734477	3 153753	8101428	4	8	08
4	8	09	1 3	20 142487	35 015025	0 5294420	3 383876	7442345	4	8	09
4	8	10	148	22 906756	39 335810	0 5834482	2 542431	8892566	4	8	10
4	8	11	84	21 735714	37 375000	0 5587498	2 241554	7941912	4	8	11
4	8	16	135	18 735555	31 473333	0 5508126	2 426570	8063908	4	8	16
4	8	17	108	22 391666	38 405555	0 5277679	2 068872	7836105	4	8	17
4	8	18	107	22 410280	37 696261	0 5459585	2 631337	8023487	4	8	18
4	8	19	36	16 694444	33 461111	0 4338242	2 538905	6672429	4	8	19
4	8	20	120	22 459166	38 814166	0 7242035	1 662368	8992536	4	8	20
4	8	21	83	21 106024	36 533734	0 6168270	2 370080	8628452	4	8	21
4	8	22	86	24 243023	42 370930	0 5397005	3 460420	6010734	4	8	22
4	8	23	108	21 931481	37 778703	0 4393789	2 656066	7476636	4	8	23
4	8	24	48	22 477083	37 400000	0 5877010	1 85[illegible]151	9246777	4	8	24
4	8	25	113	17 285840	29 606194	0 5486860	2 293266	8257894	4	8	25
4	8	26	109	14 844036	25 964220	0 6035310	1 858567	8932931	4	8	26
4	8	27	73	16 697260	28 000000	0 3263387	3 247405	6768339	4	8	27
4	8	28	112	17 164285	30 945535	0 5147064	2 041962	9486666	4	8	28
4	8	29	122	20 191803	34 781147	0 5280361	2 831652	9275817	4	8	29
4	8	30	70	23 927142	42 668571	0 7498823	1 489185	9444646	4	8	30
4	8	31	111	21 891891	38 144144	0 4187333	2 817093	8227536	4	8	31
4	8	32	110	19 721818	33 358181	0 4850815	2 176511	8290953	4	8	32
4	8	33	104	17 746153	32 118269	0 5394175	2 079502	8190265	4	8	33
4	8	34	31	14 161290	24 751612	0 6143493	1 790490	8646054	4	8	34
4	8	35	46	16 067391	29 710869	0 5778973	2 604095	7151036	4	8	35
4	8	36	107	16 671962	29 456074	0 6510997	2 514640	9272007	4	8	36
4	8	37	106	21 959433	38 360377	0 4442802	2 896788	7906190	4	8	37
4	8	38	54	20 244444	34 622222	0 5127647	2 690517	7349885	4	8	38

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p	m	k	N	$\bar{\delta}$	$\bar{A}$	b	Sy_{90}	r	p	m	k
5	1	01	152	18 401973	29 875000	0 5407305	2 158530	5345421	5	1	01
5	1	02	224	19 934375	32 095982	0 4316620	2 382628	7651030	5	1	02
5	1	07	27	24 529629	39 903703	0 6799641	1 658049	8372847	5	1	07
5	1	08	184	23 998369	38 725000	0 4982545	3 136878	8100541	5	1	08
5	1	09	200	20 318500	31 823500	0 5564413	2 480223	8807624	5	1	09
5	1	10	155	22 876129	37 101290	0 5138717	2 262365	9106282	5	1	10
5	1	11	91	21 609890	34 082417	0 5901999	2 306819	7864651	5	1	11
5	1	16	142	18 761267	31 183802	0 5528859	2 194244	8393400	5	1	16
5	1	17	115	22 553043	36 113043	0 5447951	2 146335	7825519	5	1	17
5	1	18	114	22 219298	35 623684	0 4816817	2 693965	7995378	5	1	18
5	1	19	43	18 365116	28 862790	0 5919374	2 591093	6711797	5	1	19
5	1	20	127	22 246456	36 839370	0 4750346	1 617888	8918245	5	1	20
5	1	21	90	20 978888	33 432222	0 5709016	2 095496	6904727	5	1	21
5	1	22	93	24 375268	39 006602	0 5299327	2 005596	8858713	5	1	22
5	1	23	115	22 133043	35 646956	0 5423239	2 194582	8493859	5	1	23
5	1	24	55	22 290909	36 245454	0 4619386	3 074348	7917586	5	1	24

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p	m	k	N	$\bar{\delta}$	$\bar{A}$	b	Sy_{90}	r	p	m	k
5	2	01	151	18 438410	29 923178	0 5453675	2 210860	9305640	5	2	01
5	2	02	223	19 934977	32 106726	0 4613239	2 313380	7807487	5	2	02
5	2	07	26	24 596153	40 080769	0 9526046	1 276366	9272466	5	2	07
5	2	08	183	24 021311	38 777049	0 5229281	3 055626	8197664	5	2	08
5	2	09	1 9	20 296984	31 833668	0 5606366	2 628801	8408126	5	2	09
5	2	10	154	22 872727	37 125974	0 5227775	2 308791	9070637	5	2	10
5	2	11	90	21 656666	34 163333	0 6555994	2 086672	8242221	5	2	11
5	2	16	141	18 763829	31 209929	0 5790475	2 166043	8449696	5	2	16
5	2	17	114	22 523684	36 113157	0 6025011	1 964057	8186423	5	2	17
5	2	18	113	22 243362	35 670796	0 5006438	2 667746	8028573	5	2	18
5	2	19	42	18 402380	28 957142	0 6799353	2 611653	6666294	5	2	19
5	2	20	126	22 273015	36 923015	0 4852044	1 832129	8890650	5	2	20
5	2	21	89	20 998876	33 457303	0 5957390	1 989615	9023172	5	2	21
5	2	22	92	24 347826	39 021739	0 5651390	1 812142	9078305	5	2	22
5	2	23	114	22 107894	35 678947	0 5717098	2 107764	8606700	5	2	23
5	2	24	54	22 429629	36 322222	0 4351156	3 131761	7552431	5	2	24

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p	m	k	N	$\bar{\delta}$	$\bar{A}$	b	Sy_{90}	r	p	m	k
5	4	01	149	16 510067	29 944966	0 5362819	2 572717	9029539	5	4	01
5	4	02	221	19 934841	32 067873	0 4847187	2 404083	7616731	5	4	02
5	4	07	24	24 579166	40 175000	1 1984559	0 661804	9817317	5	4	07
5	4	08	181	24 050828	38 812154	0 5349178	3 264468	7907469	5	4	08
5	4	09	1 7	20 244162	31 765989	0 5493480	3 180680	7884253	5	4	09
5	4	10	152	22 869078	37 103947	0 5231011	2 609988	8807377	5	4	10
5	4	11	88	21 718181	34 217045	0 7397760	2 018465	8342730	5	4	11
5	4	16	139	18 758273	31 195683	0 5994377	2 337143	8183651	5	4	16
5	4	17	112	22 467857	36 081250	0 6989686	1 736969	8573266	5	4	17
5	4	18	111	22 290390	35 679279	0 4975871	2 680649	7642718	5	4	18
5	4	19	40	18 460000	29 042500	0 7448316	2 857040	5844149	5	4	19
5	4	20	124	22 331451	37 028225	0 4819023	2 040311	8561437	5	4	20
5	4	21	87	21 051724	33 443678	0 6060476	2 112531	8889863	5	4	21
5	4	22	90	24 294444	38 941111	0 5873921	2 042311	8804396	5	4	22
5	4	23	112	22 062500	35 668750	0 5998661	2 194093	8467259	5	4	23
5	4	24	52	22 467307	36 369230	0 4214231	3 618450	6642933	5	4	24

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p	m	k	N	$\bar{\delta}$	$\bar{A}$	b	Sy_{90}	r	p	m	k
5	8	01	145	18 666896	30 058620	0 4986574	3 295134	8261803	5	8	01
5	8	02	217	19 943317	32 023502	0 4814152	2 737599	6773271	5	8	02
5	8	07				0 0000000	0 000000	0000000	5	8	07
5	8	08	177	24 068361	38 909039	0 5270295	3 819935	7041357	5	8	08
5	8	09	193	20 142487	31 604145	0 5164097	3 674838	6883808	5	8	09
5	8	10	148	22 906756	37 120270	0 5178080	3 051292	8358501	5	8	10
5	8	11	84	21 735714	34 291666	0 8775298	2 112124	8198486	5	8	11
5	8	16	135	18 735555	31 175555	0 6260285	2 590664	7754779	5	8	16
5	8	17	108	22 391666	36 191666	0 3024166	3 110733	3569896	5	8	17
5	8	18	107	22 410280	35 682242	0 4364775	3 405818	6349805	5	8	18
5	8	19	36	18 694444	29 188888	0 5858877	3 227876	3213388	5	8	19
5	8	20	120	22 459166	37 259166	0 4525792	2 432060	7701592	5	8	20
5	8	21	83	21 106024	33 432530	0 6072300	2 571205	8362409	5	8	21
5	8	22	86	24 243023	38 818604	0 5674842	3 045524	7108215	5	8	22
5	8	23	108	21 931481	35 674074	0 6414528	2 329230	8129303	5	8	2[illegible]
5	8	24	48	22 477083	36 554166	0 4101824	4 309112	4989177	5	8	2[illegible]

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p	m	k	N	$\bar{\delta}$	$\bar{A}$	b	Sy_{90}	r	p	m	k
6	1	01	152	18 401573	31 263157	0 5598423	1 570261	9659118	6	1	01
6	1	02	224	19 934375	33 757589	0 6398807	1 556473	9072283	6	1	02
6	1	03	245	24 051020	40 303265	0 7142641	1 492000	9502225	6	1	03
6	1	04	161	23 554037	39 519875	0 5662141	1 375730	9564252	6	1	04
6	1	05	231	24 049783	40 342424	0 6115558	1 476432	9563937	6	1	05
6	1	06	58	20 656896	34 958620	0 6679110	1 141923	9419360	6	1	06
6	1	07	195	25 320512	42 623589	0 6467652	1 496246	9358004	6	1	07
6	1	08	184	23 998369	40 795652	0 5251777	2 112855	9187063	6	1	08
6	1	09	200	20 318500	34 067000	0 5554740	1 823480	9374438	6	1	09
6	1	10	155	22 876129	38 937419	0 5806092	1 553628	9588912	6	1	10
6	1	11	91	21 609890	36 500000	0 7208274	1 196533	9477419	6	1	11
6	1	16	142	18 761267	31 375352	0 5863049	1 343190	9430098	6	1	16
6	1	17	115	22 553043	37 916260	0 7091000	1 183079	9392717	6	1	17
6	1	18	114	22 219298	37 570175	0 5870257	1 643698	9304338	6	1	18
6	1	19	43	18 365116	31 430232	0 5266056	1 662434	8796555	6	1	19
6	1	20	122	22 246456	38 184251	0 5654526	1 250145	9503776	6	1	20
6	1	21	90	20 978888	35 393333	0 5930329	1 216641	9644697	6	1	21
6	1	22	93	24 375268	41 081720	0 6454385	1 105249	9667657	6	1	22
6	1	23	115	22 133043	36 887826	0 5932864	1 526168	9302106	6	1	23
6	1	24	55	22 290909	38 070909	0 5978382	2 114787	9074401	6	1	24
6	1	25	120	17 281666	29 070000	0 6190649	1 272563	9480924	6	1	25
6	1	26	116	15 011206	26 011206	0 6519048	1 270458	9530042	6	1	26
6	1	27	80	16 117500	26 588750	0 5190865	2 241601	9042998	6	1	27
6	1	28	119	17 319327	29 942857	0 5785135	1 369187	9769275	6	1	28
6	1	29	129	20 050387	33 286821	0 6280527	1 761221	9716731	6	1	29
6	1	30	77	23 925974	39 629870	0 6331115	1 292360	9575898	6	1	30
6	1	31	118	22 050000	35 746610	0 5659048	1 506830	9529230	6	1	31
6	1	32	117	19 694871	32 71'111	0 5508453	1 481313	9223589	6	1	32
6	1	33	111	17 792792	30 760360	0 4902844	1 649560	8868727	6	1	33
6	1	34	38	14 471052	24 721052	0 4912734	1 757127	8672615	6	1	34
6	1	35	53	15 956603	27 520754	0 8125554	1 309209	9331497	6	1	35
6	1	36	114	16 224561	27 294736	0 6998395	1 623494	9737783	6	1	36
6	1	37	113	21 899115	35 731858	0 5658415	1 602107	9403430	6	1	37
6	1	38	61	20 645901	34 219672	0 5240027	1 812803	9067590	6	1	38

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p	m	k	N	$\bar{\delta}$	$\bar{A}$	b	Sy_{90}	r	p	m	k
6	2	01	151	18 438410	31 310596	0 5658834	1 621817	9632572	6	2	01
6	2	02	223	19 934977	33 774887	0 6889233	1 410635	9245697	6	2	02
6	2	03	244	24 085655	40 345491	0 7413473	1 473814	9498106	6	2	03
6	2	04	160	23 546875	39 554375	0 5773729	1 464690	9505717	5	2	04
6	2	05	230	24 053913	40 362608	0 6252176	1 555038	9516296	6	2	05
6	2	06	57	20 619298	34 966666	0 7278994	0 923816	9616048	6	2	06
6	2	07	194	25 331958	42 674226	0 6868413	1 569589	9290423	6	2	07
6	2	08	183	24 021311	40 857923	0 5329520	2 247464	9069545	6	2	08
5	2	09	199	20 296984	34 078894	0 5695242	2 339292	8942075	6	2	09
6	2	10	154	22 872727	38 967532	0 5925356	1 552464	9591043	6	2	10
6	2	11	90	21 656666	36 558888	0 7696746	1 047769	9587247	6	2	11
6	2	16	141	18 763829	31 407092	0 6124856	1 236442	9522604	6	2	16
6	2	17	114	22 523684	37 919298	0 7500306	1 086774	9481645	6	2	17
6	2	18	113	22 243362	37 509734	0 6045695	1 546303	9298632	6	2	18
6	2	19	42	18 402380	31 521426	0 5575285	1 712412	8730885	6	2	19
6	2	20	126	22 273015	38 254761	0 5801710	1 207964	9533632	6	2	20
6	2	21	89	20 998876	35 415730	0 6046335	1 173304	9671492	6	2	21
6	2	22	92	24 347826	41 059782	0 6697276	1 134048	9649529	6	2	22
6	2	23	114	22 107894	36 892982	0 6236752	1 397048	9413331	6	2	23
6	2	24	54	22 429629	38 024074	0 62267[illegible]7	1 415181	9551322	6	2	24
6	2	25	119	17 292436	29 113445	0 6404282	1 165549	9568178	6	2	25
6	2	26	115	14 992173	26 045956	0 6778635	1 140647	9623311	6	2	26
6	2	27	79	16 196202	26 644303	0 5273517	2 256104	8989290	6	2	27
6	2	28	118	17 325423	29 966101	0 5877542	1 266161	9804385	5	2	28
6	2	29	128	20 061716	33 300781	0 6353106	1 837274	9693280	6	2	29
6	2	30	76	23 965789	39 780263	0 6867959	1 117670	9682265	6	2	30
6	2	31	117	22 033333	35 762393	0 5799907	1 485624	9543071	6	2	31
6	2	32	116	19 683620	32 712931	0 5697417	1 427647	9283565	6	2	32
6	2	33	110	17 786363	30 800909	0 5225283	1 578463	8976229	6	2	33
6	2	34	37	14 464864	24 621621	0 5212977	1 804630	8611726	6	2	34
6	2	35	52	15 961538	27 626923	0 9501694	1 154106	9493212	6	2	35
6	2	36	113	16 285840	27 319469	0 7117338	1 492975	9775499	6	2	36
6	2	37	112	21 914285	35 754464	0 5799618	1 714100	9315247	6	2	37
6	2	38	60	20 561656	34 125000	0 5240093	1 917255	8888524	6	2	38

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p	m	k	N	$\bar{\delta}$	$\bar{A}$	b	Sy_{30}	r	p	m	k
6	4	01	149	18 510067	31 344295	0 5651770	2 021265	9412808	6	4	01
6	4	02	221	19 934841	33 740271	0 7268311	1 567972	9063143	6	4	02
6	4	03	242	24 143801	40 371487	0 7586822	1 849230	9157497	6	4	03
6	4	04	158	23 522784	39 566455	0 5807360	1 875764	9174551	6	4	04
6	4	05	228	24 060087	40 339912	0 6242864	2 058191	9141555	6	4	05
6	4	06	55	20 560000	34 990909	0 7735001	1 143719	9401969	6	4	06
6	4	07	192	25 362500	42 698437	0 7134214	2 197613	8545897	6	4	07
6	4	08	181	24 050828	40 922651	0 5321707	2 688155	8636601	6	4	08
6	4	09	1 7	20 244162	34 017258	0 5717738	2 797673	8409849	6	4	09
6	4	10	152	22 869078	38 953947	0 5929972	2 026312	9299430	6	4	10
6	4	11	88	21 718181	36 630681	0 8320149	1 305741	9342312	6	4	11
6	4	16	139	18 758273	31 387769	0 6230810	1 562442	9232494	6	4	16
6	4	17	112	22 467857	37 904464	0 7609505	1 320476	9202462	6	4	17
6	4	18	111	22 290990	37 608108	0 5953272	2 161329	8751458	6	4	18
6	4	19	40	18 460000	31 705000	0 5763698	2 080765	8066880	6	4	19
6	4	20	124	22 331451	38 338709	0 5859634	1 436664	9314554	6	4	20
6	4	21	87	21 051724	35 405747	0 6070365	1 469859	9478821	6	4	21
6	4	22	90	24 294444	40 956666	0 6780179	1 624473	9052571	6	4	22
6	4	23	112	22 062500	36 881250	0 6290453	1 722459	9066004	6	4	23
6	4	24	52	22 467307	37 911538	0 6414206	2 111668	8999960	6	4	24
6	4	25	117	17 306837	29 130769	0 6475522	1 455220	9324510	6	4	25
6	4	26	113	14 933628	26 052212	0 6905113	1 319593	9481937	6	4	26
6	4	27	77	16 361038	26 688311	0 5137618	2 494836	8620594	6	4	27
6	4	28	116	17 293965	29 958620	0 5926288	1 405689	9760748	6	4	28
6	4	29	126	20 106349	33 234126	0 6360919	2 428111	9462362	6	4	29
6	4	30	74	24 012162	39 990540	0 7750652	1 389195	9507965	6	4	30
6	4	31	115	21 970434	35 716521	0 5757627	1 863473	9259572	6	4	31
6	4	32	114	19 683333	32 682456	0 5860076	1 612558	9009513	6	4	32
6	4	33	108	17 769444	30 791666	0 5362074	1 722107	8779193	6	4	33
6	4	34	35	14 405714	24 480000	0 5400115	1 962697	8359279	6	4	34
6	4	35	50	16 014000	27 760000	1 1729098	1 286808	9371002	6	4	35
6	4	36	111	16 424324	27 272072	0 7270543	1 735509	9661779	6	4	36
6	4	37	110	21 967272	35 750909	0 5761425	2 222643	8812790	6	4	37
6	4	38	58	20 403448	33 877586	0 4928700	2 369450	8047067	6	4	38

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p	m	k	N	$\bar{\delta}$	$\bar{A}$	b	Sy_{90}	r	p	m	k
6	8	01	145	18 666896	31 455172	0 5434771	2 746915	8828417	6	8	01
6	8	02	217	19 943317	33 708755	0 7473085	2 083914	8284621	6	8	02
6	8	03	238	24 249579	40 434033	0 7613909	2 419029	8375381	6	8	03
6	8	04	154	23 479870	39 537012	0 5697336	2 533675	8440569	6	8	04
6	8	05	224	24 056250	40 316071	0 6110711	2 820536	8337966	6	8	05
6	8	06	51	20 317647	35 023529	0 8267083	1 251337	9130052	6	8	06
6	8	07	188	25 354255	42 756914	0 7942134	2 607941	7885954	6	8	07
6	8	08	177	24 068361	41 015819	0 5212741	3 336891	7843843	6	8	08
6	8	09	193	20 142487	33 841968	0 5624537	3 351618	7498998	6	8	09
6	8	10	148	22 906756	38 944594	0 5826115	2 721526	8719305	6	8	10
6	8	11	84	21 735714	36 776190	0 9621202	1 295607	9362896	6	8	11
6	8	16	135	18 735555	31 397037	0 6121976	2 201678	8438531	6	8	16
6	8	17	108	22 391666	37 899074	0 9500587	1 025247	9514295	6	8	17
6	8	18	107	22 410280	37 639252	0 5386481	2 935211	7461451	6	8	18
6	8	19	36	18 694444	32 083333	0 4959349	2 854662	5464769	6	8	19
6	8	20	120	22 459166	38 547500	0 5863926	1 840961	8757158	6	8	20
6	8	21	83	21 106024	35 432530	0 5991109	2 092813	8948657	6	8	21
6	8	22	86	24 243023	40 848837	0 6716946	2 667983	7491779	6	8	22
6	8	23	108	21 931481	36 842592	0 6030527	2 301603	8178343	6	8	23
6	8	24	48	22 477083	37 787500	0 6373154	3 227977	7606082	6	8	24
6	8	25	113	17 285840	29 158407	0 6398294	2 016558	8683634	6	8	25
6	8	26	109	14 844036	26 077981	0 7408738	1 564368	9256725	6	8	26
6	8	27	73	16 697260	26 742465	0 4539230	2 792823	7740779	6	8	27
6	8	28	112	17 164285	29 907142	0 5832257	1 903415	9555534	6	8	28
6	8	29	122	20 191803	33 123770	0 6344730	3 405950	8933328	6	8	29
6	8	30	70	23 927142	40 250000	0 9335760	1 462679	9464794	6	8	30
6	8	31	111	21 891891	35 595495	0 5654575	2 458451	8683021	6	8	31
6	8	32	110	19 721818	32 722727	0 5906082	2 032440	8528855	6	8	32
6	8	33	104	17 746153	30 786538	0 5506912	1 994155	8350279	6	8	33
6	8	34	31	14 161290	24 190322	0 5400664	2 338364	7545891	6	8	34
6	8	35	46	16 067391	27 950000	1 6995262	1 426110	9238266	6	8	35
6	8	36	107	16 671962	27 261682	0 7554979	2 244511	9424567	6	8	36
6	8	37	106	21 959433	35 693396	0 5901634	2 709136	8198044	6	8	37
6	8	38	54	20 244444	33 487037	0 4162820	3 199393	5914665	6	8	38

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